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"NITRAGIN."

By C. F. TOWNSEND, F.C.S.

THE extent to which even the larger animals are dependent on insignificant creatures that can only be distinguished under the high powers of the microscope is hard to realize. The longer we live the more we find out that many of these tiny organisms, far from being the harmful parasites they were once thought to be, are absolutely essential to the lives of their hosts. In our own blood are numerous small animals, called white corpuscles, that resemble in everything but size the animals known as *Amœbæ* that live in pond water. These white corpuscles, except that they cannot get out of our blood or live anywhere else, are as independent as we are. In diseases the destructive bacteria do not seem to be able to work alone in many cases, but require the assistance of other bacteria to prepare the ground for them, as it were. One of the most remarkable instances of this mutual dependence between higher and lower orders of beings lies in the vegetable world, and is concerned with the way certain families of plants obtain a portion of their food. The existence of the organisms that play a part in this particular co-operative arrangement is perhaps the most important discovery that has been made for many years, and should be of immense interest to agriculturists and others—all others.

For a long time botanists have been puzzled by the outgrowths or nodules that occur on the rootlets of plants belonging to the bean and pea family. Another curious thing about these plants is that to grow a crop of peas, beans, or tares, is as good for the land as a strong dose of manure, and many farmers, especially on the Continent, have adopted the routine of growing such a crop previous to sowing the land with wheat or other grain. The benefit obtained by doing so was obvious, although the reason was not known. Within the last few years it has been found that leguminous plants (peas, beans, etc.) had the power of making use of the free nitrogen of the air, and that the nodules on the rootlets were the channels through which the nitrogen was secured. Further investigation brought to light a very complicated and interesting state of affairs in these rootlets. In a thimbleful of soil there are many millions of tiny organisms, with which the root-hairs of the plant come into close contact. These organisms—or, rather, some of them—invade the substance of the root-hairs and stimulate the tissues to form overgrown cells, which make up the nodules we have spoken of above. As fast as the cells are formed they are occupied by quantities of organisms, which do not injure the cells, but seem to stimulate them to intense action. The result of all this is that, in a manner we do not yet understand, nitrogen is absorbed from the air in considerable amount. When the plant finds in the soil sufficient nitrogenous food (nitrates, ammonium sulphate, or farmyard manure) to supply its needs, the nodules, although they are still formed, do not take nitrogen from the air, so that the organisms must have some other business besides supplying the plant with nitrogen.

By cultivation in gelatine and selection, it has been found possible to isolate the particular organisms that take part in this curious root growth. It is found that each plant has its own organism, and in the interesting lecture of Dr. J. A. Voelcker, at the Society of Chemical Industry, a short while since, illustrations and micro-photographs of these organisms were shown. Red and white clover and other trifoliums patronize eight different forms, although it is possible that these only represent different stages in the growth of the same organism, the final shape being a three-pointed star. The form peculiar to the broad bean is very similar to the last, but two of the arms are branched again. The vetch prefers a smaller organism than the two preceding; the shape is similar, but all three arms are branched at the ends. The form peculiar to broom is that of a well-formed comma, that of gorse resembles a badly formed comma, and the organism of lucerne reminds us of a note of exclamation.

Our German friends, with their usual energy and acuteness in matters scientific, have actually begun to cultivate these organisms, and the great chemical firm of Meister, Lucius, & Brüning are offering them for sale commercially. They have chosen for them the unfortunate name of "nitragin," which is certain to be confused with "nitrogen" in this country. In Germany it does not matter, as their name for nitrogen is "stickstoff." Varieties suitable for the common pea and field pea; for vetches and horse beans; for white, yellow, and blue lupines; for red, white, and crimson clover, alsike, trefoil, cow-grass, and lucerne; for sainfoin, and many others, are cultivated.

A large number of experiments were carried out with these materials in England last year, and Dr. Voelcker gives an interesting summary of the results in his paper. Unfortunately the season was so abnormally dry that the experiments were not very conclusive, but the results on the whole were favourable. On the land of Mr. Howard

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Ryland, green peas, broad beans, and sweet peas (especially the last) benefited by inoculation; French beans were doubtful. At Messrs. Sutton & Sons' nearly the whole of the experiments gave favourable indications, especially as regards root growth. Wheat has been grown this year at Messrs. Sutton's on the ground used for these experiments, and it will be interesting to see what improvement, if any, has been effected.

By the light of present experience, it is necessary to take the following precautions when using the new inoculating material: the ground must either be inoculated before sowing, or the seed itself must be inoculated, and the organisms sown with the seed. This is important, as the nodules are formed in the early stages of the growth of the plant. As the inoculation only assists the plant to obtain the nitrogenous portion of its food, other manures, such as phosphates and potash, must be supplied, just as in the ordinary way. Where a particular crop—say, of beans—is doing well, it is foolish to expect to improve matters still more by introducing the new material, as it is quite clear that the soil is already inoculated. Further and more elaborate experiments with "nitragin" are being conducted this year, and we hope they will lead to definite rules of conduct being laid down.

One of the most hopeful applications of the new inoculating material is in connection with "clover sickness." It is found in practice that clover can only be grown for a comparatively short time on a particular piece of land; the soil then becomes "clover sick," and about eight years must elapse before the field can be sown again with clover successfully. The reason for this is unknown, but it may be due to the exhaustion of the organisms that live on the roots, without which the plant cannot thrive. If this be the case, the application of fresh inoculating material will enable the farmer to grow clover every year, if he desires it, off the same plot.

The knowledge of these organisms throws a light on the fact that, as every gardener knows, manure alone, however well proportioned, is not sufficient for the satisfactory growth of most plants; it is necessary to have a large quantity of decayed vegetable matter present as well. An old garden that has been well looked after produces far better crops than one newly planted, the difference being due in all probability to the quantity of these useful organisms present in the old vegetable soil.

Important as the discovery of root organisms may, and probably will, be to agriculture, the application seems small compared to the immense possibilities that are opened up in the region of chemical industry. On the one hand we have this inert nitrogen of the air, that can only be made to combine with other elements under the stress of the greatest force at the command of chemistry and physics, viz., the electric arc; on the other hand, these tiny organisms are making nitrogen enter into combination at the ordinary temperature of the soil. When the secret of these organisms has been mastered, we shall have drawn much closer to the boundary that separates gods and men.

FAIRY FLIES.

By Fred. Enock, F.L.S., F.E.S.

If it were possible to obtain a reply from all living naturalists as to what first attracted their attention to insect life, I venture to think that seventy-five per cent. or more of the replies would be: "The first sight of a living butterfly." How many of us (no matter what our speciality may now be) can look back to that time when, perhaps, a tortoiseshell flaunted its beauty before our youthful eyes, and we were drawn to it and fascinated by its gorgeous colour, as it delicately sipped the nectar from a dandelion or thistle, gently opening and shutting its wings, spreading them as wide as possible so that every part should be seen! The colours and markings flashed before our enraptured gaze, and while we were held captive by its beauty, another still more beautiful butterfly—the peacock—sailed past and alighted close to the first, rivetting our attention by the marvellously lovely "eyes" on its wings; and again another—this time a red admiral—in full sail bore down upon us, opened fire, and we surrendered, swearing allegiance for evermore to Atalanta and all her crew. Few boys could stand still and not be affected or influenced by such beauty. Such then has been, and will be, the foundation of our naturalists—"butterfly hunters" first, specialists later on.

My recollections carry me back a long way, to the time when, in passing a cobbler's shop, I saw some cases of insects hanging against the wall. They very soon attracted me, and many delightful hours did I spend sitting close to "Daddy Lucas" listening to the wonderful accounts of how he caught his butterflies and moths. Since those delightful years of childhood I have noticed that—from butterflies and moths—a few schoolboys collect beetles and dragon flies; but *Diptera* and *Hymenoptera* are not collected. Blowflies belong to the first, and bees and wasps to the second, and both sting, and so are left alone except when a nest is discovered; then boys do collect together, to join in the attraction of danger, the marvellous structure of the nest being knocked to pieces with as little compunction as a palace in time of war.

The insects included in the class *Hymenoptera* are of vast extent and variety, comprising many of the most beneficial, as well as some of the most destructive, to all crops. Among the latter may be mentioned the gooseberry sawfly, which at certain seasons denudes the bushes of every vestige of green leaf; but this pest can be much lessened and got rid of if preventive measures be taken in good time, instead of stupidly allowing the damage to go on before one's eyes. There is no easier or more effectual method for destroying these grubs than that of opening an umbrella, turning it upside down, and holding it underneath the bushes, the branches of which should be gently tapped, when the grubs will fall down into the open umbrella; hundreds and thousands may be caught in a very short time—and all turned into a vessel of boiling water. Delay this easy remedy, and the grubs become full fed, then burrow below ground, where they spin small earth-coloured cocoons, in which they change to pupæ—a future harvest for evil. The turnip sawfly grub or "nigger" might be, and ought to be, looked after, and its numbers could easily be lessened were systematic and combined measures taken; but until such happy times both gooseberry and turnip sawflies will go on sawing. How many of the merry wearers of the oak-apples on May 29th—"Royal Oak Day"—know or ever think what forms the "apples" or "oak-'taters" (Worcestershire)? Few imagine that a small hymenopterous insect is the founder of these wonderful "galls"; but so it is, and the cycle of the life history of a single oak-apple and its contents would astonish anyone. To another insect belonging to the *Hymenoptera* there is not a single man, woman, or child who does not owe a debt of gratitude for the incalculable blessing of ink, which is manufactured from the oak-gall found in Turkey. This gall is gathered before the fly has escaped, so that it is what may be termed of "full flavour" and "bitter as gall."

Following the gallflies, we may turn to the *Ichneumonidæ*—a large family to which lepidopterists often bear a

FIG. 1.—Caraphractus cinctus (Male).

FIG. 2.—Caraphractus cinctus (Female), showing position when flying in the water).

FIG. 3.—Caraphractus cinctus (Female).

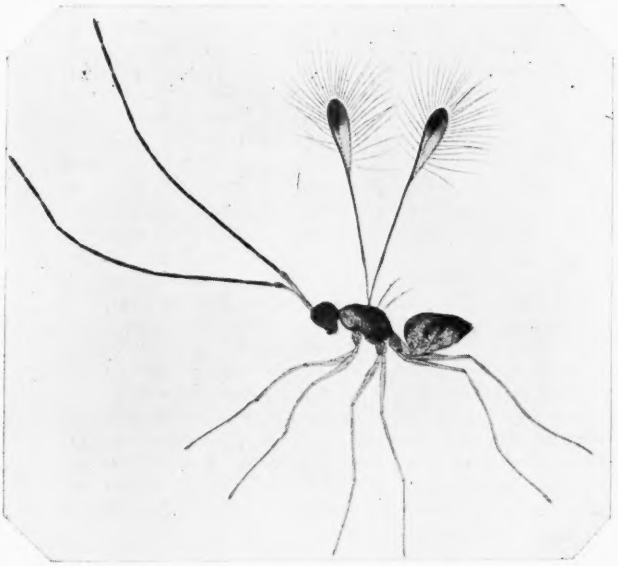

FIG. 4.—Mymar pulchellus (Male).

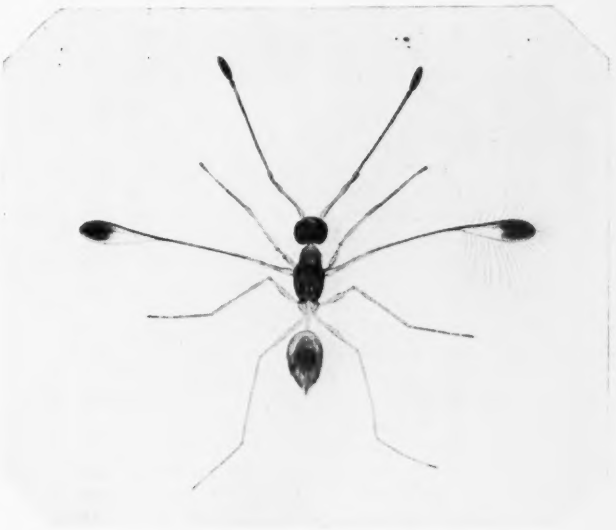

FIG. 5.—Mymar pulchellus (Female).

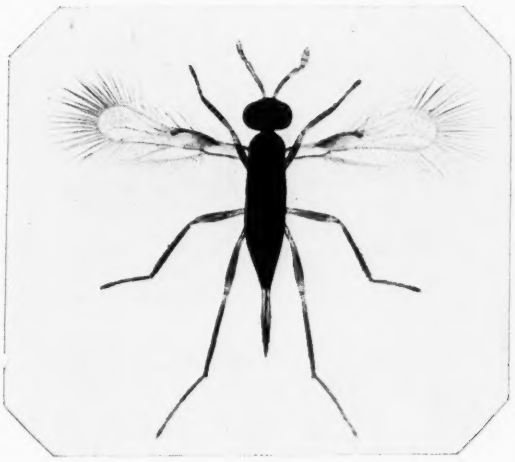

FIG. 6.—Prestwichia aquatica (Female).

FIG. 7.—Prestwichia aquatica (Male).

FIG. 8.—Cosmocoma fumipennis (Female).

FAIRY FLIES. (Magnified 30 Diams.)

From Photo-micrographs by FRED. ENOCK.

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grudge for destroying many of their rarest captures of larvæ and pupæ. We can all remember the bitter disappointment experienced on finding a round hole in a pet pupa, and, instead of the expected moth, a fierce and active four-winged ichneumon fly. Time softens our disappointment, and now we prefer the parasite. It is a pleasure to record the fact that the members of the South London Entomological Society are all contributing specimens of parasites bred each season. The collection is assuming great importance, and will be of considerable assistance to future students of this much-neglected branch.

As we are briefly running through the *Hymenoptera* our difficulties seem to increase, for with the next division, the *Chalcididæ*, we hardly know what to do, or to whom we can turn for assistance in naming these brilliantly spangled green and gold coloured flies, whose "name is legion." The labourers in this field are indeed few, so much so that there is not a "specialist" even at the Natural History Museum, South Kensington. Among the British bees and wasps we have an able and willing helper in Mr. Edward Saunders, to whom I am personally indebted for help time after time. A few years ago I was enjoying a short holiday at Portland, where, during a sudden burst of sunshine, I caught a few (as I thought) "common things," which I sent on to Mr. Saunders to name. His reply informed me that one of the specimens was of great rarity, being the second on record of *Aporus bicolor*. The wood and sand boring wasps (*Crabronidæ*) are of immense interest from their habit of storing up, for their future progeny, insects of various orders. The large *Crabro cribrarius* searches for craneflies, whereas another collects certain species of *Syrphus*. At the present time I have several species under close observation, and have already observed *Crabro cribrarius* take over two dozen craneflies down its burrow, and, strange to say, these are not of a common species. Years ago at Hampstead Heath there used to be a corner known as the "horse exercise ground," bounded on one side by a high grassy bank, in which various bees had colonized, notably *Eucera longicornis;* adjoining this bank was a yellow sandbank, fairly riddled with holes, made by *Cerceris arenaria*. At the time I speak of (twenty years ago) one could sit down in peace and quietly watch these industrious insects bringing in their provisions for their future progeny. These provisions always consisted of *Strophosomus obesus*, a beautiful beetle whose elytra are covered with broad scales, giving the creature the appearance of being clothed in bronze coinage. The nearest spot where I found these beetles was at Highgate Woods—another old collecting ground, but not now. Others of this family collect spiders, frog-hoppers, etc.

Works on ants are fairly plentiful, but we don't know all their ways yet. If anyone be desirous of studying the ways of *Formica rufa*, the wood ant, I can confidently recommend St. George's Hill, Weybridge, as a good locality where you can see, hear, smell, and feel them! But you may have too much of the latter sense, so I advise coat sleeves and trousers bottoms to be tied up tightly, and a green net put over the head and tied as tight as bearable round the neck. Some of the "ant-hills" are two feet high, and anyone who wishes to see insect life has only to place a walking stick in the centre of the heap of pine needles—but making observations and notes on the spot is decidedly lively work.

Having briefly indicated how many fruitful fields are open for the industrious student of entomology, let us go back to one of those "neglected families" which have received but small attention. One reason for this want of attention is, no doubt, because of the extreme smallness of the members of this family, the largest being not more than one-twentieth of an inch long, whereas the smallest is less than one eighty-fifth of an inch from head to tail. These insect atoms have been classed among the *Chalcididæ* by Haliday—the originator of the *Mymaridæ*—who first noticed them in 1833. Since that date Westwood has placed them among the *Proctotrupidæ;* and now Ashmead—author of American *Proctotripidæ*—has decided in favour of Haliday's arrangement, and in this I fully concur.

The fairy flies are, without doubt, among the many wonderful parasitic *Hymenoptera*, the most admirable in their exquisite structure, as well as in their habits and economy. All the species are egg parasites, and each species has its peculiar taste, selecting with unerring instinct the right kind of egg—generally that of an injurious insect—in which the female lays one of its own eggs, which in due time hatches or develops into an active maggot. This maggot feeds upon the contained fluids, and finds sufficient nutriment to bring it to full size, when it assumes the pupal stage. The fly, being matured, bites out a round piece of the egg shell large enough to allow it to escape. The most noticeable character in the fairy flies is the transverse line across the face a little above the insertion of the antennæ. The wings are devoid of all wing nerves, for the subcostal is so short and stumpy that the wing looks perfectly free. Both the upper and under surfaces of the wings are covered with minute hairs, and the margins of both wings are surrounded by long hairlike *ciliæ*.

Owing to the kindness of the authorities of Dublin Museum, I have been permitted to make a most exhaustive and critical examination of Haliday's type collection of British *Mymaridæ*, and though the hand of time and those of others have materially interfered with their original arrangement, the result has been most satisfactory to me. Although one or two of the most interesting types are absent, I have been enabled to re-establish Haliday's genus *Panthus*, which certain compilers had, for no apparent reason, ignored. I found two specimens still bearing the old labels, and after long and critical microscopic examination I saw that both were distinct from any others. I applied for and obtained permission to remove the carded specimens, and remount them in Canada balsam. This was successfully done, and on making a photo-micrograph the peculiar generic characters were brought out most distinctly. Some naturalists appear to imagine that a pocket lens will be sufficient to identify these species, but in an insect which is but a fiftieth or an eightieth of an inch long it is of absolute importance that every joint and detail should be examined under the microscope, and the relative proportion of each joint of the antennæ be compared with closely allied species—just as they are with all large *Hymenoptera*. The curve, too, of the delicate wings is a most important feature which must not be hurried over. This point leads me to speak of the immense superiority of photo-micrographs over drawings of these fairy flies. No matter how exact an enthusiastic naturalist may be in his endeavours, it is a physical impossibility for anyone to follow out and reproduce the exact curve of these microscopic wings; and as the flies when properly prepared and "set" in Canada balsam lend themselves peculiarly to photo-micrography, it is wise to take advantage of this. The details can afterwards be drawn to a much larger scale. It is my intention to do this with every species which I have collected during the past twenty years, and of which I have a very large number, far exceeding those known to science. The illustrations accompanying this short article will, I think, show what exceedingly good subjects the fairy flies are for photo-micrographs.

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Since Haliday's arrangement of the British *Mymaridæ*, elucidated by Francis Walker, no new species have been recorded, the genera numbering eleven, the species thirty-five, as follows, viz. :—

Ooctonus, four species.	*Mymar*, one species.
Gonatocerus, five species.	*Cosmocoma*, eight species.
Alaptus, two species.	*Caraphractus*, one species.
Litus, one species.	*Anaphes*, seven species.
Eustochus, one species.	*Anagrus*, four species.

Camptoptera, one species.

Of these I have found representatives of all, and a few notes may not be uninteresting to those who desire to search for these fairy flies.

Ooctonus. Of this genus I have not found very many specimens. It is thick set, and least like a fairy. Unfortunately Haliday did not publish any detailed account of his captures, but from the fact of his naming one (plentifully represented in his collection) *Ooctonus hemipterus*, it is just possible it may be parasitic in eggs of bugs.

Gonatocerus is, perhaps, as plentiful as any in the London district. It is a constant visitor to my garden, though I have failed to discover its nidus.

Alaptus minimus and *fusculus* have long been known to me. The first-named is not more than one seventy-second of an inch long, with a sessile abdomen. Its wings are somewhat hatchet shaped, with peculiar enlargements at the base of the inner margin. The lower wings have a crimped appearance, arising from the mackerel marking. This, and in fact all the family, are to be found running up the glass in a greenhouse, especially on the window facing east. *Alaptus fusculus* is one of the first to appear in spring —its peculiar jerky gait will at once reveal its identity. Of this species I have bred hundreds from the eggs of a psocid (*Stenopscocus cruciatus*), an insect much like a common aphis, but very active and shy, having a decided objection to being watched. But "all good things come to those who know how to wait," and wait he must for hours, days, months, and years before the life history of a single species is made out. Haliday mentions that *Polynema* (*Cosmocoma*) destroys the eggs of the cabbage butterfly. I read this twenty years ago, but I have never yet found one egg "struck." *Stenopscocus* lays its eggs on the leaves of various shrubs and trees. I have found them on lime, oak, sycamore, hawthorn, and ivy. They are laid in patches of ten to twenty, the female psocid carefully weaving a silken covering to endeavour to protect them from the attacks of enemies; but, alas! who would imagine a fairy fly to be an enemy? Yet its microscopic size enables it to pass unnoticed, and also permits its passing beneath the silken screen, and, once there, woe betide the psocid's eggs! for the busy fairy taps one with her clubbed antennæ, mounts to the summit, and then lets down the ovipositor until the barbed tip touches the surface of the fresh-laid egg (it must be fresh). Now by carefully focussing a good magnifier, we can observe the fairy taking a firm hold of the surface of the egg with the two curved tips of each of her exquisitely formed toes! Next we note that pressure is being put upon the barbed ovipositor. The antennæ are pressed firmly to the surface, and impress the observer with the fact that some very serious business is in hand. Eleven minutes have passed without any sign of a move, when just after eleven and a quarter the ovipositor positively bumps through the shell. There is another serious pause, and then up go the clubbed antennæ, and very carefully the ovipositor is withdrawn until it slips back between the sheaths. The fairy turns round, and with saliva from her mouth seals up the incision. Another egg is ascended, bored, and stored with an egg—and so on until the whole patch of twenty has been struck, and all chance of any psocid emerging utterly ruined. I kept the first batch of eggs which I had seen struck in October until the following year, when, as the warm days of April arrived, I carefully examined them, until one eventful day I observed one of the eggs had a tiny hole in it. On placing it under the microscope I saw a pair of mandibles busily at work nibbling away the egg shell, until at last the hole was large enough to admit of the head being thrust through. After many efforts the antennæ were freed, followed by the first pair of legs; then, with this additional leverage at command, the thorax was lifted out, the second pair of legs and part of the wings following, and after much apparently painful effort the third and last pair of legs was withdrawn, enabling the fairy to walk out, and to free those most exquisitely delicate wings without a hitch. Now, taking a firm grip on the empty egg shell, the fairy went through her toilet. Not a hair or spine escaped attention—each and every part of this microscopic marvel received the utmost attention; every hair forming the lovely marginal fringe was brushed out and arranged in exact order. The wings were raised several times to try them, and then away this atom of perfection flew. Since my first seeing the oviposition of a fairy fly I have dissected many struck eggs, and in less than a minute had the germ (laid by the fairy fly) under my microscope, and watched it grow, and the cells divide again and again in such a marvellous manner that I have been lost in wonderment or simply overcome. Flesh and blood is not strong enough to carry on such watchings too long, but the fascination is so great that time after time have I watched the mysterious changes taking place—various organs being formed under my eyes—the active larva gradually losing all its activity until it appears in pupal form, and then new limbs and organs seem to be evolved from nothing at all.

The next genus, *Litus*, is a peculiar one. Its one representative, *Litus cynipseus*, much resembles a flea in colour and form. It is the only fairy fly that takes its time in walking. I have never seen it in a hurry, neither have I ever seen the male—and the female is not a plentiful species.

Eustochus is distinguished by having a deeply marked suture across the club of the antennæ, and though Haliday mentions but one species I have found over a dozen; in fact, of this genus I can always find specimens anywhere —on windows, in greenhouses, in railway carriages, besides sweeping them up from grass and all kinds of herbage. I have also seen and caught them flying, and have obtained many specimens from spiders' webs.

Mymar pulchellus is, without doubt, the most extraordinary of the whole family. My first specimen I caught in a spider's web when living near Finsbury Park. It was very much held by viscid globules, but after many hours' work appeared in Canada balsam a splendid mount. No insect has exercised my power of thought more than this one; but its life history remains a mystery still, though I imagine I am within measurable distance of discovering its nidus. Fig. 4, the male, and Fig. 5, the female, will give a good idea of the surpassing delicacy of this fairy fly. The posterior wings are abnormal—mere bristles—and yet they are of immense service when hooked into the anterior ones, the black specks just before the tips of these bristle-like wings being the three hooklets. (*See* Fig 4.) In Fig. 5 the wings are hooked together.

The next representative, *Cosmocoma*, is Haliday's *Polynema*, which, he states, affects the eggs of the cabbage butterfly. Fig. 8 represents *C. fumipennis*, which is of the most strikingly beautiful character. I once saw the male

of this, but it was on the glass outside the greenhouse, whilst I was inside and the door was locked. My feelings at that moment can be better imagined than described.

Caraphractus cinctus (Fig. 1, male—Figs. 2 and 3, female) has received a good deal of attention and notoriety from the fact that in 1862 Sir John Lubbock discovered that it was aquatic in its habits, using its wings for swimming under water (Fig. 2). It was christened *Polynema natans* by the worthy discoverer of its natatorial habits; but in 1896 it fell to my lot to prove it to be identical with Haliday's *Caraphractus*. Further research has proved that the mymarid bred by M. Ganin from eggs of the dragon fly is not (as has been stated) identical with *Caraphractus*. At the same time that Sir John Lubbock observed this aquatic fairy he also discovered another aquatic *Hymenopteron*, which used its legs only for swimming; this he named *Prestwichia aquatica*—and though Rev. T. A. Marshall has included it in his list of British *Mymaridæ*, it has no right to such a place. Fig. 6, the female, shows a very distinct subcostal nerve turning inwards and ending abruptly, which feature is never found in any of the *Mymaridæ*. It was not until June 20th, 1896, that I had the pleasure of first discovering the male (Fig. 7) of this interesting *Hymenopteron*. It has the merest rudiments of wings.

Anaphes is found in almost any garden, and is frequently confounded with *Eustochus*, but the solid club is an unfailing character. It is also somewhat larger than *Eustochus*.

Anagrus contains many species of very delicate yellow fairy flies, always present in gardens and about ponds—in fact, almost everywhere. I have been again fortunate in discovering the life history of several species belonging to this genus. One is parasitic in eggs of dragon flies, and three others in different kinds of eggs of frog-hoppers, which have for over thirty years eluded my search until the present year.

One more genus remains to be noticed, and it is the most fairylike of all the *Mymaridæ*, viz., *Camptoptera papaveris*. It is the smallest of the family, the female being but one eighty-fifth of an inch long. Mystery surrounds this gem, and yet it is most plentiful in certain localities—Woking for instance, where, on one day, September 6th, 1885, I caught over three hundred females crawling up the windows facing east. The male, of which I have only taken two specimens, measures just one ninety-second of an inch from head to tail, and yet is absolutely perfect in every part.

MORE ABOUT ANTIVENENE.

By Dr. J. G. McPherson, F.R.S.E.,

Mathematical Examiner in the University of St. Andrew's.

TWO years ago we gave the digest of two lectures by Prof. Fraser, of Edinburgh, on the cure for snake bites. Having ascertained the minimum dose of snake poison required to cause the death of an animal, he started below that amount, and gradually increased the dose after intervals of ten days. By this process he found the animal receiving as much at one time as fifty times the amount of the minimum lethal dose, without it causing any bad effects to the animal. The blood serum of these immunized animals, which he named "antivenene," was then used as an antidote for the venom. He took a fresh animal and injected the poison, as in a snake bite, waiting till symptoms of poisoning were manifest; at once he injected the antivenene, and put a stop to any further progress of the poisoning. This showed that the antivenene is really an antidote to the poison of snakes.

In the course of his experiments, Prof. Fraser observed a peculiar fact, viz., that dietary had an effect upon venom poisoning. Venom is almost inert when introduced into the stomach, or any other part of the alimentary canal. By gradual increases, he introduced at one time into the stomach of a cat a dose of venom eighty times larger than would have killed a clean cat by injection, yet no observable disturbance was produced by these doses.

Carrying on his experiments, Prof. Fraser examined the antivenomous properties of the bile of serpents and other animals, and he has just given to the Royal Society of Edinburgh an explanation of the unsusceptibility of animals to the poisonous action of venom introduced into the stomach. After repeated experiments on white rats, he found that when the snake's poison is introduced into the stomach it does not produce any active poisoning effects, but some of it seems to become absorbed into the animal's blood so as to assist in the immunization. Why was this? In Prof. Fraser's opinion, when venom is introduced into the stomach, the chemical changes wrought by the acids of the stomach destroy its fatality to a large extent. With the view of proving this he made experiments upon rabbits with a mixture consisting of a lethal dose of venom and varying quantities of the bile of the African cobra, the rattlesnake, and the puff-adder—three of the most deadly of the serpent tribe. This mixture was not introduced into the stomach, but injected subcutaneously. When the proportion of bile was small, the animal operated upon invariably died within three or four hours; but when the quantity of bile was increased the animal recovered after a period of torpor. He also experimented with a mixture consisting of a lethal dose of African cobra venom and the bile of the grass snake—an innocuous serpent; but in this case he found it was necessary to increase very largely the dose of the grass snake bile—nearly seventy times greater—before results not terminating in death were obtained. He is now of opinion that the bile of all animals is more or less antivenomous, but the more venomous of the serpents produce the most effective bile. It would not do, he considered, to inject subcutaneously a quantity of bile taken from a venomous serpent into a person, say, half an hour after being bitten by a venomous serpent, sufficient to render the venom harmless, because the bile would most probably itself produce death by its own poisonous properties. It must be introduced *through the stomach* or applied to the wound.

He had experienced great difficulty in getting a supply of serpent bile in its natural state, so he got a friend of his in India to send him a small quantity of alcoholic precipitate of cobra bile, with which he experimented; but the results were not quite so satisfactory. As a further proof that bile is able to render venom innocuous, he stated that it was now a well-known fact that it enters into the composition of all the wonderful remedies used by Indian snake doctors for snake bites; although they do not care to admit the correctness of it, as they fear to say anything which would lessen their hold upon the superstitious feelings of the people. Serpent bile is so difficult to obtain that the snake doctors usually employ venom as an antidote in the first place; and only when this shows certain signs of failure do they fall back on their precious store of bile. They rub it into the wound.

Bile is secreted in large quantities by all animals, and

Prof. Fraser is of opinion that many organic poisons which get introduced into the system are rendered non-effective by the action of the bile. This throws considerable light on the great service rendered by bile to the system, besides its necessary use in the process of digestion. It was long known that bile has an antiseptic action, diminishing the putrefactive changes of the intestinal contents; but Prof. Fraser has good reason to believe that it acts as an antivenene for many poisonous substances which get into the stomach with the food, and which cannot be detected in the preparation of the food.

Thus gradually is Prof. Fraser enlightening the world by his successful experiments on the antidotes to poisons. The addition of snake bile to the immunized serum to form a powerful antivenene is a most valuable discovery, and gives evidence of the great advance made in medicine during recent years, when the thyroid preparation for myxœdema and the antitoxin for diphtheria, and such like, have startled the medical world. Prof. Fraser deserves the hearty thanks of the scientific world for his unwearying patience in investigating this most important and comparatively new subject.

PIT-VIPERS.

By LIONEL JERVIS.

THE classification of ophidians is the bane of zoology, and of the making of catalogues there is no end. Nevertheless, we have reason to congratulate ourselves on the classification of the *Crotalinæ* in the "Catalogue of Snakes in the British Museum (Natural History)," Vol. III., dated 1896. Following, apparently, the lines adopted for the classification of the rattlesnakes, the author has, by a happy analogy, brought under the one comprehensive heading of *Lachesis*, including forty species only, a group of serpents described in the works of former naturalists by considerably over one hundred and twenty different titles.

I do not propose here to differentiate minutely between the various species by enumerating those in which the tail is or is not prehensile, or in which the second upper labial forms the anterior border of the loreal pit, or in which the pit is separated from the labials by scales, etc., etc. Students of herpetology are probably already in possession of the catalogue, to which they can readily refer; while to the casual reader such details would only be tedious.

I regret that I am unable to say anything new about the most characteristic feature of the *Crotalinæ*, the loreal pit, lying between the eyes and the nose. The nearest approach to the true solution of the question appears to me to be the theory that it contains the organ of an unknown sense. On this point a famous herpetologist writes that it was found that "the lining was supplied with a thick nerve, ending in a way the only analogue of which is found in the retina of the eye and the labyrinth of the ear"; and, again: "It does not seem doubtful that we have here to do with a true sense organ." It is not necessary to quote more extensively in respect of a subject on which I am not prepared to elucidate any of the solutions already offered; but whether the pit supplies a distinct sixth sense, or whether it is supplementary to any of the others, it is certain that few creatures have greater need of help in this direction, for it is evident that the sense of taste is almost altogether absent, while their sight and hearing are notoriously feeble.

In the popular mind the viper is regarded with feelings in which the element of fear is predominant, and perhaps it will not be amiss to discuss how far this fear is justified with regard to the *Lachesis* family in comparison with other venomous snakes. In order to arrive at a satisfactory conclusion on this subject it will be necessary to consider three main points—the method of attack, the virulence of the venom, and the disposition of the snake. The two latter vary with the species, and will be touched on later on, and I shall now endeavour to explain the method of attack of a large pit-viper.

When disturbed or irritated the snake throws itself into coil, the posterior half of the body—the base of operations—being in spiral circles, while the anterior half—the aggressive portion—is bent back on itself in several lateral curves; the head is slightly raised and is directed towards the object to be struck. The moment this comes within range the muscles on the outer sides of the curves are suddenly and violently contracted, so that the head and the upper part of the body are darted forward with great rapidity; "Le serpent se déroule," as an old French writer expressively puts it.

As soon as the forward thrust has commenced, but not till then, the mouth is opened to an angle of nearly one hundred and eighty degrees, the skull itself being bent backwards on the neck to a considerable extent. Simultaneously the snake, by the action of the spheno-pterygoid muscle, causes the maxillary bone—in all vipers very short—to partially revolve, so that the fangs are elevated from their normal position parallel to the roof of the mouth, to an angle of forty-five degrees (or rather more, so as to allow for the curve of the fangs) to the upper jaw, so that the points may be directed straight towards the object of attack. It has been frequently stated that the elevation of the fangs is due to the opening of the mouth, owing, no doubt, to these actions usually taking place simultaneously; but, as a matter of fact, this is not the case, as the snake has perfect control over them, erecting and depressing them at will, either together or independently of each other.

As soon as the fangs have entered the flesh of the victim, the muscles which act in antagonism to the spheno-pterygoid depress the points, driving them deeper into the wound; and, immediately after, the snake closes its lower jaw sharply onto the bitten part, with the double object of momentarily retaining its hold and of injecting the poison, the venom gland being compressed by one (amongst others) of the muscles closing the jaw.

All these actions take place almost co-instantaneously, and particular attention is directed to the two last, as they considerably modify the danger of the attack, for should the snake misjudge its distance—a not infrequent occurrence—the depression of the fangs may take place a fraction of a second too early, and consequently the outer curves and not the points will strike the skin, and the flesh will not be penetrated. Moreover, in order to avoid biting its own lower jaw, the snake separates its fangs (the extremities of the mandibulars being at the same time brought closer together), so that they point outside the mouth, and consequently, if the object is narrow—the finger, for instance—it sometimes happens that they will pass on either side of it. Nevertheless, it is perfectly clear that any object in the line of the thrust will be penetrated, except at the commencement of the stroke, before it has gathered force, or at the finish, when the points of the fangs may have been depressed too soon.

By way of comparison let us now consider the attack of the cobra (*Naja*), as one of the best known and most venomous of serpents. Here it is important to appreciate

the difference in the position of the fangs of the viper and the cobra at the time of striking: in the former they are erectile, and, as just shown, are pointed straight at the victim; in the latter, owing to the length of the maxillary bone, they are practically immovable, and when the snake is about to bite they are nearly in the same position as the "holders" of a dog when springing forward with open mouth—that is to say, they point downwards and slightly backwards. When attacking, the cobra raises the anterior third of its body, and strikes forward and downward, the head being projected in a curve similar to that described by the point of a sword in a forward and downward cut; the line taken by the points of the viper's fangs, on the other hand, resembling that of the point of the sword in a thrust. Bearing in mind the fixed position of the cobra's fangs, it is obvious that only at certain limited portions of this curve can the stroke be dangerous. I have, indeed, had an opportunity of testing this myself. I was explaining the structure of the hood of the cobra, and, with the object of calling attention to one particular feature, I pointed with my finger close to the glass. Instantly the snake struck at it with great apparent ferocity, and I noticed that when the head came in contact with the glass it had already begun to descend, and consequently the blow was given with the upper part of the rostral shield and not with the fangs. It is clear, therefore, that, even if the glass had not been there, the worst I should have had to fear (besides the nervous shock) would have been a smart crack on the hand from the snake's nose; and had I encountered the stroke a little earlier, I should have been struck by the front curve of the fangs, and not the dangerous downward drive of the points. In confirmation of this view, I observe that Sir Joseph Fayrer, in his "Thanatophidia of India," records that on one occasion he had a cobra and a mongoose put together in a cage. After fighting for some time they were separated, and it was found that the mongoose was bleeding freely about the head from several scratches from the snake's fangs, but it showed no symptoms of poisoning. Subsequently the cobra was made to close its jaws on the mongoose's thigh, and the poor brute soon succumbed to the effect of the venom. It may be suggested that I have here selected a serpent which is handicapped by the frill-like expansion of the loose skin round its neck—the so-called hood—both as to the rapidity and accuracy of its stroke, on the same principle that an oar is moved less quickly through the air with the blade squared than with the blade feathered. It is true that the cobra is the worst shot I have ever seen, but the same argument as to the comparative danger of the attack of snakes with fixed fangs, and of vipers, applies to kindred and very venomous serpents, such as the African mamba (*Dendraspis*), and the Australian black snake, sometimes called the purple death-adder (*Pseudechis porphyriaca*).

It must be remembered, both as regards the danger of the attack and the virulence of the poison, that the normally recumbent position of the viper's fangs admits of much greater development than in those of the poisonous colubrines, and that consequently the wound inflicted is as a rule deeper, and the poison therefore more thoroughly inoculated into the system; on the other hand, they are extremely brittle and liable to be broken off.

There is no doubt that the toxic properties of the poison of cobras and kindred snakes are much more active than in that of vipers, notwithstanding the fact that the record in Sir J. Fayrer's experiments is held, I believe, by one of the latter, a fowl having died from the bite of a Russell snake (*Vipera Russellii*) in forty-eight seconds. In speaking of this serpent the same authority observes that though the poison is slower in taking effect than that of the cobra, the results were almost invariably fatal. Nevertheless it is quite clear that the longer the victim lives, the better is the chance of counteracting the poison and saving his life; and it is to be hoped that the attention which for some time has been directed to this subject will result in some definite and reliable antidote being discovered.

Of all venomous serpents the hamadryad (*Naja Bungarus*) of the East Indies is popularly accredited with being the fiercest in disposition, as it is undoubtedly the largest in size, sometimes attaining a length of fourteen feet. If half the stories about it are true, it not only fiercely resents being disturbed, but actually pursues the unfortunate intruder; in fact, its sole virtue seems to be a propensity to cannibalism. It has a rival in South Africa, the mamba (*Dendraspis*). I have frequently conversed with travellers and residents in South Africa on the subject of poisonous snakes, and have noticed that, while they speak of such brutes as the puff-adder and cobra with comparative indifference, they always refer to the mamba with an amount of seriousness which warrants the belief that the danger of an encounter with one is very real. This serpent appears to be absolutely aggressive, and will come down from a tree merely for the sake of a fight. The fact that it is arboreal makes it all the more dangerous, as one is liable to be bitten in the face. It is remarkable that two serpents, the Indian rat-snake (*Zamenis mucosus*) and the Cape bucephalus (*Dispholidus typus*), which are quite harmless (the poison of the Cape bucephalus is not strong enough to injure human beings), so greatly resemble the hamadryad and the mamba respectively that they frequently pay the penalty of mistaken identity with their lives.

Some at any rate of the *Lachesis* are stated to be equally fierce, and although I have some hesitation in believing that they are actually aggressive, I see no reason for doubting that they will attack on very slight provocation. The two worst offenders are reported to be the bushmaster (*Lachesis mutus*), largest and fiercest of vipers, and the *fer de lance* (*Lachesis lanceolatus*), also a good-sized snake; while I have heard bad accounts of the *vivora de la cruz* of Argentina (*Lachesis alternatus*). But the East Indian varieties, the old *Trimeresurids*, do not seem to be so dangerous as their American cousins, and are also inferior in size.

A friend of mine tells me that he was entering his hut in the West Indies, and was closing the lower half of the door—which was divided like an ordinary stable-door—when he was startled by a *fer de lance* striking at him from a beam or shelf inside the hut, with such violence that it passed over his shoulder and fell outside. There is a mountain in the same neighbourhood supposed to be inaccessible, both from natural difficulties and from being infested with these serpents.

In conclusion, it will only be proper to say something about the father of the family (*Lachesis mutus*). Linnæus, judging, no doubt, that the structure of the end of the tail—several rows of very small keeled scales ending in a spine—contained the rudiments of a rattle, classified it as a rattlesnake under the name of *Crotalus mutus*, the silent rattlesnake—the rattler which cannot rattle. Other naturalists, however, differing from Linnæus, and perhaps finding that the other Fates had been appropriated by other vipers—*Clotho* by the puff-adder and others, and *Atropos* by the berg-adder—altered the appellation to *Lachesis*, which was very sensible; but retained the *mutus*, which was idiotic, as the term loses all its significance when apart from *Crotalus*.

XUM

THE EDGE OF A CONTINENT.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

PROF. ALBERT DE LAPPARENT, in the preface to his charming "Leçons de Géographie Physique,"* points out how in France, of late years, instruction in physical geography has been entrusted to geologists, and how his own book should be regarded as a sort of bridge thrown between two sciences. "The study of the surface-features of the present day," he writes, "must never be separated from the consideration of the past that gave them birth." Sir Archibald Geikie has already impressed this on us in regard to the teaching of geography:† "In dealing with topographical features, the teacher ought, for his own sake as well as that of his pupils, to make himself master of the general geological structure of the country on which he is about to give lessons." And there is no doubt that such studies will impress keenly upon him the lack of repose that is characteristic of existing features.

It is on the edges of the great continents that we may look for evidence of this instability and change—change rapid enough, at any rate, to be measured by a time-unit of a thousand or even five hundred years. Where the land meets the sea, even the earliest human inhabitants of the district must have become accustomed to the destructive wash of waters, or to the silting up of passages and caves. Rock-shelves, on which one might sit and fish with primitive lines into deep water, became slowly undermined, and eventually perished in a single night of storm. Grooves between rocky walls, into which canoes could be safely run, became useless through the movement of pebbles or sand from some distant portion of the coast; and, in time, the old men of a settlement could tell even stranger tales, of remains of houses dimly seen at the falling of the tide—relics of antique and doubtless fairy races, now vanished, with all their belongings, in the sea.

On the other hand, well-arranged beds of sea-shells and sand, far above the level of storm-wash and high water, pointed to a former extension of the sea across the land; and behind these phenomena lay some of the most controverted questions of geology.

Despite the opposition of those who sat in mediæval libraries, and who judged all nature by the span of their own cabined lives, we now know, as freely as the old-time fishermen, that the huge sandbanks are piled grain by grain against the coast, and that the broad-mouthed bays are carved by the swirl of the sea-waves. But the shell beds lying above the level of the sea, and other evidence of changes in the general relations of sea and land, still form matter for serious debate, and still demand the closest observation.

In the present article we may apply what may be seen on special portions of the coastline to the whole margin of sea and land—to the continental edge itself. From this point of view we soon learn that what we call the mean sea-level is not a surface of uniform curvature, or an ellipsoid enclosing a smooth and theoretical earth, but is bent up or down according to the nearness or remoteness of the continental mass; so that the sea-level is high against the land, and low in the centre of the oceans. Could we remove the attraction of the continental masses, many oceanic islands would thus disappear beneath the waves.

Experiments with the pendulum have proved so much, though local features—the density of rock-masses and so forth—exert a disturbing influence. A pendulum of such a length that it should, for the particular latitude, swing from one end to the other of its course in one second, is found to swing too slowly at sea-level on the edge of a continent and too rapidly at sea-level on an oceanic island. The pendulum is, in fact, farther away from the centre of the earth in the one place than it is at the other, although both may be upon the same latitude.

Now, the constant waste of high land-surfaces, through the action of rain and frost and rivers, is reducing the mass of land above the sea-level, and is letting the sea slip back towards more uniform conditions. As the sea retreats, it should leave behind it traces of its former extension, and sea-shells should thus be found high and dry some hundreds of feet up against the coast.

We may suspect, however, that such action is so very gradual that the denuding agents remove the marine deposits as they come above the level of high water during the retreat of the surface of the sea. Anything like well-marked marine terraces, where an eroded surface is accompanied by old sea-caves, could not be formed by so continuous a process of retreat; we should be forced to imagine the intervention of a long period when the denudation of the highland was at a standstill.

Moreover, over long distances of the continental edge, the traces of old sea-levels, left behind in this manner, would be at the same elevation, or would rise steadily towards the region where the greatest masses stood above the sea. Anything like warping of the old shore-lines, such as has been observed in the south of Sweden,* must be due to movement of the solid land itself.

Ice-masses have naturally been invoked to account for some of the raised beaches; an unusual accumulation of Polar ice would draw the oceanic waters northward, and would raise the sea-level along our shores. But Lord Kelvin† has shown that the enormous thickness of ice at one time demanded is a physical impossibility in an unenclosed basin, owing to the outward viscous flow of the material, which tends, even at Polar temperatures, to thin and flatten the whole mass. Nor would all the ice postulated by the extremest glacialist account for the uptilting or local curvature of the shell-beds or terraces that are left behind. The Chaix Hills of Alaska, to quote one fine example, are composed of strata containing shells still living in the adjacent ocean;‡ yet these beds, four thousand to five thousand feet in thickness, are bent up so as to dip northward at an angle of ten to fifteen degrees over a distance of about nine miles. We have here, along the coastline of the Pacific, a range of hills three thousand feet in height—we should call them mountains in our own country—produced by a comparatively modern uplift along the continental edge.

Whether we study the American seaboard, down to the volcanic line of Chile and Peru, or the coral coast of the Indies and Australia, or our own storm-swept western promontories, we find the same series of phenomena, the same problems to be solved. It seems generally agreed, by this time, that continental margins are unstable, and that they mark lines of movement in the crust or skin of the earth. The North American continent is actually flanked by mountain-chains formed of intensely crumpled strata; and South America presents towards the

* Paris: Masson & Cie., 1896.

† "The Teaching of Geography," p. 166. (Macmillan & Co., 1887.)

* See, for instance, Penck: "Morphologie der Erdoberfläche," Bd. II., p. 538.

† "Popular Lectures and Addresses," Vol. II., p. 346.

‡ I. C. Russell: "Second Expedition to Mount St. Elias in 1891," Thirteenth Annual Report, United States Geological Survey, p. 25.

Pacific its magnificent backbone of the Andes. The Pacific as a whole is ringed about with earth-folds, the details of which indicate a spreading of the continents at the expense of the ocean-basin; and the progress of movement along these lines of weakness is marked by violent volcanic action. The Atlantic, on the other hand, shows no such symmetry of structure;* but the whole of the western lands of Europe, from Norway to the Spanish plateaux, may be regarded as an uplifted rim to the huge compound continent on the east. The chains that run east and west, such as the axis of the Pyrenees and the post-Carboniferous folds of Kerry, have been broken off or bent down towards the depressions of the Atlantic; and the tendency of earth-movement in late geological times is probably shown by the volcanic line running almost north and south, from the Faroe Islands through the Inner Hebrides, the vents of Antrim, and onward to the Wolf Rock off Cornwall. May we not also include the north and south line of Pliocene volcanoes, the Monts Dôme of Central France, as an indication of the system of fractures which determined our present continental edge?

Prof. Suess† has insisted much on the contrast between the folded margins of the Pacific and those of the Atlantic, the latter ocean having no relation to the growth of mountain-chains. Along the Pacific, work is evidently being done, and the deep oceanic depressions bordering the continental edges are the submerged limbs of the folds that form those edges. The late Prof. J. D. Dana long ago pointed out how the earth-ridges and the long oceanic grooves were related to one another, the greater mountain-chain having the deeper depression along its flank. In a word, as he urged, the highest mountains face the deepest portions of the ocean, and their steeper flanks descend towards the oceans.

An aggravating number of exceptions occurs, as Prof.

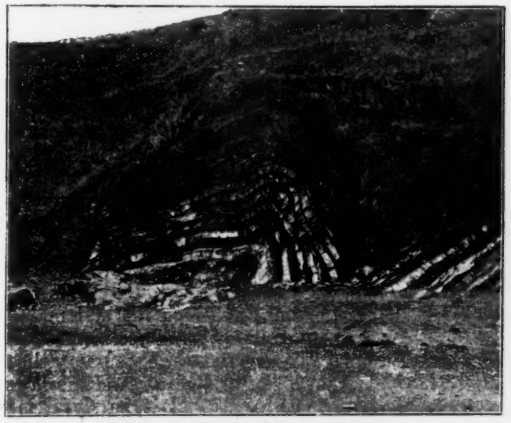

FIG. 1.—Fold in Limestone, Loughshinny, Co. Dublin, illustrating the formation of a Continental Edge by elevation, a corresponding Oceanic Depression being formed by the lower limb of the fold.

Heilprin‡ has pointed out; but he agrees with Dana that in many of these cases the mountains have formed the borders of oceanic areas in recent geological times. All round the world each great earth-fold is completed by its sunken limb,§ and the sea is likely to flow into the hollow thus provided, and to move outward or inward on the continental edge according as the fold is thrust forward or retreats. (Fig. 1.) A fold may even become dead; compression may have done its worst upon that line of the crust, and the region that once was weak may have become strengthened, as it were, by a cicatrice. The differential movement in the crust is transferred to new directions, and the whole of the older folds, the mountain-ridges and the ocean grooves, becomes uplifted as a portion of a complex continent.

Again—as Suess has suggested for the Atlantic—an oceanic area, as we now know it, may be a vast region of depression, bounded by a series of fractures (faults) along its margin. The continental edge is thus formed of material

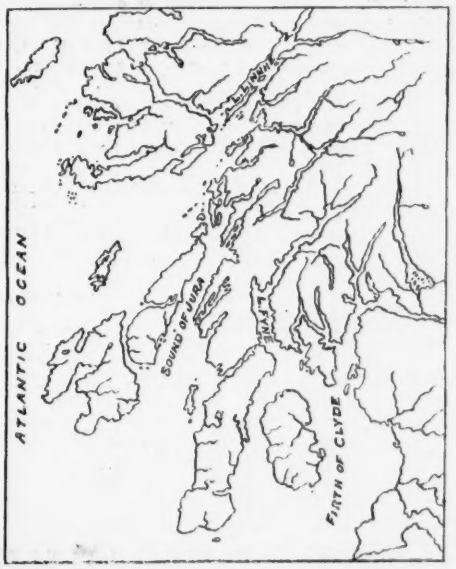

FIG. 2.—Coastline in the south-west of Scotland, showing typical Fjords and accompanying Islands. The latter are usually formed by the submergence of the *cols*, or the passes from one valley to another, the intervening higher portions of the valley-wall remaining above the sea as islands. (Distance from north to south, one hundred and five miles.)

left behind on the "upthrow" side of the fault, and the fault-plane itself approximately forms its seaward face. This face cuts across earlier features, and is only occasionally influenced by them. Earth-movement has again determined the position of the continental edge upon the map, but no definite line of folding occurs to emphasise the margin.

On such a coast, fjords will be frequent, owing to the dragging downwards of the margin of the land; the river valleys are lowered beneath the sea, and the long characteristic inlets result, so well known on the coast of Scotland and of Norway (Fig. 2). The old shorelines that can be traced at varying heights along their flanks point to a time, or to successive times, when the depression was greater than now, or when the sea (according to some writers) was held at a higher level against the continent. The variable height, however, of the terraces in different fjords points to uplift as the cause of their present relation to the sea. The fjord, then, was at one time even deeper than it is at the present day. Whether the continental border is due to folding or to faulting, it is easy to realise how its present position represents the sum of many movements, some involving slow depression, others slow

* *See* Suess, "Antlitz der Erde," Bd. II., pp. 164-6, and 258, 261; and Lapworth, Address to Geological Section, British Association, *Nature*, Vol. XLVI. (1892), p. 377.

† *See* also Penck, *op. cit.*, p. 570.

‡ "The Earth and its Story," p. 185. (Boston, 1896.)

§ *See* Lapworth, *op. cit.*, p. 375.

upheaval. The sea-worn terraces and raised beaches mark the longer pauses in these movements.

The depth of typical fjords often increases rapidly in their inner reaches, the mouth being comparatively shallow. This appears to be due to actual bending of the original valley-floor—a phenomenon that has also converted Alpine valleys into lakes; but the peculiar narrowness of fjords, and their freedom from detrital infillings, are usually ascribed to their having once been occupied by glaciers. The river of ice, extending from wall to wall, protects the valley sides from weathering, and carries off any stones and dust that may fall from the high peaks above. At the same time, deltas and alluvial flats cannot be formed upon the floor by stream-action. The glaciers continued to occupy these valleys until after the land sank beneath the sea, and the ravines were thus preserved in all their original grandeur. When we pass outside latitudes in which glaciation is a common feature, true fjords cease to occur upon the continental edge. Submerged valleys are, however, common, giving rise to inlets that clearly were never excavated by the sea. Such inlets are usually wider at their mouths than is the case in typical fjords, and are shallowed in their inner reaches by sedimentary deposits from the land. Von Richthofen proposed to call them "rias," from their occurrence under that name in the Spanish province of Galicia (Fig. 3), and the term has now become somewhat widely spread. It seems, however, that ancient fjords must become worn away and filled up until they resemble "rias." Suess and others have referred the "fjords" of south-west Ireland to the "ria" type; but it is highly probable that at one time they were occupied by glaciers, and possessed the characters of genuine fjords.

Fig. 3.—Coastline of Coruña and Pontevedra, Galicia, showing so-called "Rias." (Distance from north to south, one hundred miles.)

Perhaps we have said enough to indicate the tendency of modern investigation with regard to continental edges, at any rate from a structural point of view. The British Isles, standing as they do on the European plateau, but with their western edges close against the Atlantic depths, serve as excellent examples of the complex character of a coastline. On the east, we have the delta-deposits and smoother outlines against the shallows of the North Sea; and the east of Ireland shows similar features towards the channel that separates it from England. While the firths of Moray and of Forth in eastern Scotland indicate subsidence, they remind us of the "ria" type, and the depth within them rarely exceeds twenty-five fathoms. The west coast of Scotland and of Ireland, and the south-west coast of England, abound, however, in submerged valleys, and show typical fjord-structure in the more northern regions. We need only instance Loch Etive, Loch Fyne (with its one hundred and four fathoms of water), and the so-called Killary Bay.

When we seek to correlate the continental edge of Europe with the geological structure of our own islands, we see that the hard and ancient masses of north-western Ireland and of western Scotland, folded into ridges with a north-east and south-west trend, continue the great Scandinavian peninsula, of which they are obviously a part. Though the actual continental edge lies one hundred to two hundred miles to the west of these Scotch and Irish ridges, it seems natural to suppose that they have influenced its direction as well as its position, if only by their power of resistance. Farther south, however, as in Kerry, the edge is at right angles to the direction of the ridges on the land, and the fjords or "rias" creep up along the trend of the folded Carboniferous and Devonian strata. It is noteworthy that the last earth-folding of which we have clear evidence in England—namely, that which drove the Pliocene sea back from the Downs of Kent and Surrey—gave us a ridge of chalk running east and west, in complete independence of the edge of the continental plateau. That edge, however, may have been farther to the west in Pliocene times, and a good deal of oscillation has doubtless taken place along it since it was established in its present situation. The supposed fixity of ocean-boundaries, which at one time threatened to become a dogma among geologists, has ceased to confine our speculations. At the same time, our duty lies in patient observation. The study of folded strata in a small cliff-section may aid us in the more difficult task of investigating a mountain-chain; and our mountain-chains, with their vertical and horizontal movements, may in time allow us to correctly appreciate the complexity of a continental border-line.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

WIND AS AN AID TO FLIGHT.

To the Editors of Knowledge.

Sirs,—Mr. Headley's article in your issue for August contains a startling dynamical theory which appears to me to be based upon a misapprehension. I am not anxious to cavil unnecessarily, and so I pass over his confusion of the terms *inertia* and *momentum*—which he uses indifferently and apparently considers synonymous—and will deal with the article as if he had used only the latter term.

My quarrel is not, of course, with the statement that a breeze will help a bird to rise. The fact in that statement is almost as obvious as the fact that air, still or moving, is necessary to "flight"; what excites surprise is the statement that "inequalities of the wind" can give momentum upwards to a bird, or to anything else for that matter.

Mr. Headley tells us that "a uniform horizontal breeze cannot lift or maintain a heavy body in the air unless that body has momentum of its own." Very true! but surely not very new! But then he goes on to imply that a wind that is "unequal or not uniform" *can* lift and maintain a heavy body when that body has no momentum of its own, and this seems a baseless and quite visionary theory. If it were true it would certainly be new, and the laws of dynamics would have to be revised. But, surely, it is not asking too much when I wish for some proof of the truth of this novel theory before I accept it as a natural law. As far as the article goes, we have nothing further in the way of proof than a reiteration of the statement in different words. "When a bird rises," says Mr. Headley, "with wings outspread and motionless, there must be inequality, supposing the wind is horizontal." But that is mere repetition of the unverified hypothesis. Would it not be more in accord with what we know of the laws of motion to say: "When a bird rises with wings outspread and motionless through a horizontal wind, there must be a momentum in the mass of his body acquired independently of the layer of wind through which he is rising. When that momentum is exhausted the horizontal wind will not counteract gravity, and the bird with motionless

wings will fall, no matter how unequal in velocity the horizontal wind may be." Mr. Headley supposes that the bird, at the moment of his ascending from the slower moving stratum of air into the swifter moving one, "is part of the slowly moving stratum below"; but surely, if he is part of the slowly moving stratum, it is because he *is being carried with the stratum*, and not because he has risen through it. Again, when he has passed through the second stratum and is emerging into a third still more swiftly moving one, if he "is a part of" the second stratum it is because he has been carried with the stratum, and so its force has been expended in carrying the bird along; but Mr. Headley's theory is that the force of the current has gone to lift the bird. On which horse will Mr. Headley ride? It seems clear that the bird cannot be "part of the current" at the same time that the current has expended its force in lifting him. The lark's motion upward is surely the resultant of the forces which are acting upon him. One of these forces is that of the wind he breasts; but to say that a steady wind would have no effect and an unequal wind a great effect is to say a thing which is hard of belief.

I do not quite follow Mr. Headley's meaning when he speaks of birds "advancing at right angles to the wind." Perhaps he means "in the teeth" of the wind; but that is surely not at right angles to it. There is something also of a portentous wildfowl which can, by a "twist at the waist," turn suddenly; but this must be a "bird of paradise," for no bird of this world could perform such a feat. A very puzzling passage, too, is that in which we are told of birds that rise "in spirals, without a motion of their wings." To do this they must face every point of the compass in succession, and cannot therefore breast the wind, which it seemed part of Mr. Headley's theory they should do. The subject is truly interesting, and has long been so. The "way of an eagle in the air" was a puzzle to Solomon. It is to be hoped Mr. Headley will not be deterred by criticism, but be spurred to find the true solution.

J. H. S. MOXLEY.

Royal Hospital, Chelsea, S.W.

[Mr. Moxley's objections have been many times stated and met.

Lord Rayleigh and other high authorities have shown that a horizontal wind of unequal velocity can help a bird to rise, whereas a uniform horizontal wind is of no assistance at all. A few years back there appeared in *Nature* a number of letters dealing with this subject. In these letters, writers who thoroughly understood dynamics made clear what is very easy to grasp—that a bird may be lifted by a horizontal wind that increases in velocity with altitude, if only he has inertia. Inertia he must have at the outset, and as he rises into each successive stratum of air he will still be, relatively to the breeze in which he is, an inert body, since he has just emerged from the slower current below.

It is unimportant to distinguish inertia and momentum in this connection. When a boy, holding the string of his kite, stands still, the kite has inertia and rises; if he runs with the string in his hand, the kite has momentum and rises.

With regard to mere irregularities—and they are great even in what we call a steady wind—Prof. Langley has made out a strong case for his view that a soaring bird may make use of these no less than of the more dependable increase of velocity with altitude. As to the power of some birds to rise in spirals without a motion of their wings, they do achieve this feat, and I can only recommend Mr. Moxley to go and see them. The gain in elevation takes place when they are facing the wind—whenever through their momentum or inertia they can feel the wind blowing in their faces.

Gulls do advance at right angles to the wind. Having risen to some not great height above the ground or sea, they descend, making at the same time progress onward; then they turn and face the wind, which, since its force increases with altitude, lifts them.—F. W. HEADLEY.]

THE BERLIN URANIA STERNWARTE.

To the Editors of KNOWLEDGE.

SIRS,—The Urania Sternwarte having been mentioned in your last issue as an example of a public institution devoted to the interests of popular astronomy, may I be permitted to add a few words concerning this excellent enterprise, as well as concerning the facilities generally which are offered to the amateur in Berlin? The Urania Institution was founded in 1888, and has been since then considerably enlarged—a new branch having been opened only quite recently. It now comprises various departments for the illustration of physics, optics, chemistry, electricity, etc., besides the astronomical observatory, which, however, alone concerns us at present. Among the five large telescopes which are here placed at the disposal of the public every fine evening until eleven o'clock, there is a fine twelve-inch refractor mounted in a dome with rising floor, as also a reflector of about eight inches aperture. In the daytime the solar spots and faculæ are shown by projection, and the various details of the observatory are explained by the attendants. There are also exhibited various examples of astronomical photography, as well as models of telescopes and plaster casts representing lunar craters, while a reading room is provided where current astronomical literature may be consulted. Attached to the institute are two theatres—one for the delivery of lectures illustrated by the usual lantern slides, while the other is reserved for more spectacular effects, and is therefore fitted with the usual accessories of an ordinary theatre, the lecturer occupying a small balcony at the side of the stage. The lectures given in this latter theatre are, however, chiefly noted for their scenic effects, and are not always astronomical. Nevertheless, some tableaux recently produced here, representing a series of lunar landscapes, were admirable, both in artistic effect and selenographic accuracy. Though this may perhaps border on the "playground of science" rather too closely, there is still sufficient solid matter to suit the tastes of the more sober minded, and this (exclusive of the lectures) may be obtained for an entrance fee equivalent to sixpence. Mention must also be made of the well-known monthly publication *Himmel und Erde*, which is issued by the Urania Society.

Should the amateur's interest impel him to seek still further details, he may visit the Royal Observatory, where all the instruments will be fully explained to him—the Observatory being open to the public free on two mornings in the week; or he may visit the Royal Astrophysical Observatory at Potsdam, which is open free to visitors every Friday afternoon. Here he will also receive full particulars of the principal instruments forming the equipment of this splendid observatory, soon to be further enriched by the addition of a thirty-two inch photographic refractor.

Adjoining Herr Archenhold's telescope at the Berlin Industrial Exhibition last year there was an astronomical museum on a small scale. It consisted mainly of exhibits which had been lent for the occasion, *e.g.*, maps, documents, and instruments of historical interest, astronomical photographs (the most popular amongst which were Dr. Weinek's beautiful lunar enlargements) telescope

XUM

models, and large discs of glass for objectives, etc. The museum proved itself fairly attractive, though doubtless the majority of visitors came in the hope of getting a glimpse through the "giant telescope," of which so much had been expected, and which, owing to its lamentably unfinished condition, caused such widespread disappointment.

Notwithstanding the facilities Berlin thus offers for encouraging a popular interest in astronomy, there are comparatively few amateurs to be found, and but little more than a spasmodic interest is taken in the science; while an organized body of observers such as the British Astronomical Association can show does not—and, indeed, scarcely could—exist amongst a people who, in matters of study at least, carry specialization to the extent of limitation. W. ALFRED PARR.

Nettelbeckstrasse, 6, Berlin, W.,
August 10th, 1897.

VENUS.

To the Editors of KNOWLEDGE.

SIRS,—Some of your readers may be interested to know that Venus is still clearly visible in daylight.

She is now considerably north of the sun, which is, of course, an advantage.

I saw her on August 7th at 10.30 A.M., and as late as 12.25 P.M.; again on the 10th very clearly, from 11.37 till noon; and again on the 11th, as late as 12.15 P.M.

I have always observed from inside a room. The great thing is to be shaded, not only from the direct light of the sun, but also from the brightness of the sky.

August 14th, 1897. P. M. RYVES.

VEGETATION OF AUSTRALASIA.

To the Editors of KNOWLEDGE.

SIRS,—In your issue of May last, Mr. Hemsley, in his interesting article "On the Vegetation of Australasia," makes the statement that "the flora of Australia contains comparatively few plants yielding products of economic value." This requires—as I think you will allow when glancing over the list of trees, etc., given hereunder—some little modification. Mr. Bailey, our Government Botanist, remarks that they are all worthy of cultivation and the produce known to commerce. *Antidesma Bunias, A. Dallachyanum, A. erostre, A. Ghæsembilla, A. parvifolium, Atalantia glauca, Citrus australis, C. australasica, C. sanguinea, C. inodora, Davidsonia pruriens, Diploglottis Cunninghamii, D. diphillostegia, Eugenia eucalyptoides, E. grandis, E. hemilampra, E. Johnsonii, E. myrtifolia, E. Tierneyana, E. Wilsonii, Ficus gracilipes* (and forty others of the same genus), *Garcinia Mestoni, Leptomeria acida, Nephelium Lautereri-anum, Rhodomyrtus macrocarpa, Rubus rosæfolius, Schizomeria ovata, Vitis acetosa, V. nitens, V. opaca, V. hypoglauca.* The above list is compiled from a paper read by Mr. Bailey before the Australasian Association for the Advancement of Science, Brisbane, 1895, and could be augmented considerably, not only from the Queensland flora but by additions from the other colonies. I think, however, it is quite long enough to show that Mr. Hemsley errs somewhat in his statement. The fruits—many being of large size, and *V. acetosa* bearing bunches averaging from one pound to two pounds in weight—are used by the settlers for a variety of purposes, in which jam and wine making largely predominate. F. WHITTERON.

Iarmga, *viâ* Brisbane, Queensland,
July 2nd, 1897.

[I venture to assert that if Mr. Whitteron had carefully read the opening sentences of my article, to which he refers, he would not have written the foregoing letter. Having studied the flora of Australia for nearly forty years, and having specially collected all information that has come under my observation bearing on the economic uses of plants by the aborigines, by the early explorers, and by the colonists, I certainly should not make the statement Mr. Whitteron erroneously attributes to me. Consequently it is unnecessary for me to reply to his communication in detail. It is true that the flora of Queensland is much richer in useful plants, and especially of plants yielding edible fruits, than any other part of Australia; but the flora of Queensland contains a relatively large Asiatic element, as distinguished from the characteristic Australian vegetation. I imagine, too—though I have not the paper referred to—that Mr. Bailey, whom he cites as his authority, will be surprised to learn that the produce of the plants named is known to commerce. As to *Ficus gracilipes*, and the forty other species of the same genus, nothing could possibly be more misleading than such a general statement, though it is true that some of these figs bear an edible, if not a very luscious fruit. Both Mr. Bailey and Mr. Maiden (author of a comprehensive work on the economic botany of Australia) will, I believe, agree that I have not minimized the value of the vegetable products of Australia.—W. BOTTING HEMSLEY.]

THE LANGUAGE OF SHAKESPEARE'S GREENWOOD.

To the Editors of KNOWLEDGE.

SIRS,—It is difficult to ascertain what is the exact purport of Mr. Morley's two articles on "The Language of Shakespeare's Greenwood." If he wished to show the connection between Shakespeare's language and that of the Warwickshire peasant of to-day, he has done very little indeed; in fact, he gives us but a few instances, the equal of which could probably be adduced from any dialect in the country. If he wished to give examples of the virility or poetical force of the Warwickshire dialect or turn of expression, he has certainly succeeded in a few instances. "Scaramouch" is a fine word—I never heard it before—and "folly-fit" is a splendid participial compound; it is one of those words that would enrich our standard English. If, however, he desired to show us the exclusiveness of the Warwickshire dialect, he cannot by any means be said to have succeeded. Your correspondent who writes from Kent points out that the word Mr. Morley selects above all others as a type of this exclusiveness is in use in his county. I am well acquainted with the dialect of Staffordshire (not the Warwickshire side, but that portion most distant, on the borders of Cheshire and Derbyshire), and I can testify to the frequent use of "lather" (with "a" short) for ladder, as well as "blather" and "blether" for bladder. In fact, there is near the town of Leek a ridge known as Ladderedge, but always in common speech "Latheredge." Mr. Morley seems to have overlooked "burthen," which has its place in literary English. Another word selected of exclusive Warwickshire use is "cade." Some of its applications may be local, but I have always heard a lamb reared by hand called a "cade," and occasionally the term transferred to a spoilt child. As for "nesh"—which is also commonly used in Yorkshire both as an adjective and a verb—"lace," to thrash; "yarbs" (herbs); "wench," in the affectionate and familiar meaning in which "lass" is used in Yorkshire and "lassie" in Scotland; "moither," to harass or worry; "favour," to resemble a parent—all are quite familiar in the dialect of the district I have alluded to. Then the terminal "n" seems to Mr. Morley quite a curiosity. In "housen" this is but the plural ending, as in "oxen," and

the "eyne" and "treen" of the poets. If Mr. Morley will go into North Staffordshire he will hear "shoon" daily, and "housen" often. If he will get amongst the youngsters he may soon hear of "brids' naysen," *i.e.*, birds' "neesen" or nests.

"Hisn," "hern," etc., are everyday terms, and suggest formation from "his own," etc. Probably this is a more simple explanation than the possible one that these forms are double genitives, the simple genitive in Anglo-Saxon being "his," but certain words forming that case in "an" (singular) and "ena" (plural).

A more curious use of the terminal "n" is met with in the North Staffordshire dialect in the phrases "a thisn" (in this way), "a thatn" (in that way), "an sichn" (and such like). It has occurred to me that these are possibly survivals of the old accusative endings in "n," that case being used adverbially in Anglo-Saxon.

Mr. Morley may be interested to know that his word "recklin'," is used in Staffordshire in the form of "ritlin'," and is always then applied to the weakly pig of the farrow.

I must admit that I have read Mr. Morley's articles with much interest, but probably a wider acquaintance with other dialects would make him a little more modest in his claims for his Warwickshire greenwood.

EDWARD SNELGROVE.

Heeley, Sheffield, July 20th, 1897.

To the Editors of KNOWLEDGE.

SIRS,—Mr. George Morley may be interested to know that the following peculiarities mentioned in "The Language of Shakespeare's Greenwood" are in vogue in the rural districts of Shropshire:—

Country folk always drop their "g's" in words ending with "ing." "Wench" is very commonly used, especially when speaking of a mare. "Urchin" is frequently used to imply a hedgehog. A mug or drink of beer is known as a "tot o' beer." "On" is almost invariably used instead of "of." A farmer will speak of his "wuts" (oats). A countryman always uses "hisn," "ourn," and "theirn," instead of his, ours, theirs, but never (that I have heard) adds an "n" to any substantive such as "housen." One commonly hears the remark, "He favours his father"—or mother.

These expressions are not peculiar to any one part, but are heard throughout the county.

Ashley House, Shrewsbury, August 13th, 1897. W. LYON BROWNE, Jun.

Science Notes.

THE editors have decided to add a new and permanent feature to KNOWLEDGE, in the form of a column or so in each number to be specially devoted to notes relating to the habits and migrations of British birds—and, indeed, to any observations which are of value and interest to ornithologists. This department will be commenced in the next issue of KNOWLEDGE, and full particulars will then be given.

A distinguished company assembled in Shrewsbury on the 10th of August to witness the unveiling of the new statue of Darwin, presented to his native place by the Shropshire Horticultural Society. The ceremony was performed in charming weather by Lord Kenyon, who was supported by the Bishop of Shrewsbury, Mr. Lawson Tait, Mr. Stanley Leighton, M.P., Sir J. D. Hooker and Lady Hooker, the Head Master of Shrewsbury School, the sculptor (Mr. Horace Montford), Prof. George H. Darwin, Mr. W. E. Darwin, and many others. Shrewsbury was *en fête* for the occasion, and all classes of the people combined to do honour to the memory of their famous townsman. Sir Joseph Hooker contributed some interesting reminiscences of his forty years' association with Darwin, and referred to his indomitable perseverance under bodily suffering; his command of all the available sources of knowledge in any given subject of research; his strong and vivid grasp of the most difficult subjects; and his power of turning to account the waste observations of his predecessors and contemporaries. "It is dogged that does it" was a maxim of Darwin's, and Sir Joseph Hooker instanced his congratulating himself that his very illness had allowed him to read off on sleepless nights his continuous observations on the movements of his plants.

A new scientific series will make its appearance during the course of the autumn, the first volume of which may be expected early in October. Mr. Beddard, F.R.S., is the editor, and Bliss, Sands, & Co. are the publishers. It will be entitled, "The Progressive Science Series," a title which is intended to be indicative of the character and scope of the volumes as opposed to a series whose objects were merely historical or expository. In other words, the volumes, although not in any way neglecting history or exposition, will endeavour to point towards the line of future discoveries in each particular branch, and save investigators trouble by going over ground that has recently been trodden without result.

Prof. Ladislas Weinek, Director of the Prague Observatory, is about to publish a great photographic atlas of the moon, containing two hundred maps, twenty-six centimètres by thirty-one, and showing the principal lunar formations viewed under the most varied conditions of illumination. The originals from which these enlargements are made are one hundred in number—ninety-four from the Lick Observatory, four from that of Paris, two from that of Arequipa. The Lick negatives have been enlarged to twenty-four times the original scale, bringing the resulting enlargements to a scale of ten feet for the mean diameter of the moon. These maps will be executed by a phototypic method direct from the glass enlargements by the well-known photographic institute of Carl Bellmann, Prague, and will be issued in sets of twenty, to appear at intervals of two or three months until the first series of two hundred maps is completed. Should sufficient subscribers be obtained—as we most sincerely trust will be the case, for it will be a distinct loss to science if the fullest advantage of Dr. Weinek's most skilful and patient work be not secured by the astronomical public—a second issue of two hundred other maps will follow the first, the two together giving a very complete view of the lunar surface under a wide range of conditions of illumination. The subscription for the first series of two hundred maps is ten pounds. The specimen plate, "Maginus," from a negative taken on 1895, October 9th, affords an excellent guarantee for the beauty of execution and minuteness of detail of the whole.

The fact that the vast basin of the Yukon River, in Alaska and British Columbia, is extremely rich in auriferous deposits, has lately been brought to the attention of the general public by the discovery of gold in large quantities in the bed of the Klondyke River and neighbouring streams. It must not be supposed, however, that the district has only lately been found to be a gold-bearing one. A few miners entered the region by the Chilkoot Pass in 1880, and since then a yearly increasing number have gone there by the same route. In 1893 there were about three hundred miners in the district, but the reports of their successful operations attracted over

three thousand in 1895, and last year probably more than double that number were engaged in washing gold from the gravels of the Yukon and its tributaries, while the total output of the year reached a value of nearly five million dollars. It is interesting to note that Dr. George Dawson, now the Director of the Geological Survey of Canada, prophesied the recent gold discoveries in a report of an exploration in the Yukon district and adjacent northern portion of British Columbia, made ten years ago. Dr. Dawson's report, which appears in the "Report of the Geological Survey of Canada" (1887-88), should be seen by everyone who wishes to obtain a clear, unvarnished statement of the resources of the region.

The South Pole has for long been left undisturbed by the explorer, and has never attracted as much attention as the opposite Pole. The new Belgian expedition, however, is by no means the first to visit the Antarctic Sea. The scientific staff of the present expedition consists of a geologist, a lieutenant of artillery, who has charge of the magnetic and meteorological apparatus, an expert dredger, and a physician. The *Belgica* is a whaling vessel of two hundred and sixty-three tons, barque rigged, and with a speed of seven knots. She has been furnished with every sort of apparatus likely to facilitate the objects of the expedition. Soundings to any depth will be taken with the sounding-line invented by the Prince of Monaco, fishing will be possible at a depth of four thousand feet, and the animal life of the upper sea-beds will be made the subject of study. It is expected that the *Belgica* will be absent about two years. Captain de Gerlache, in a recent interview, described his objects as being little dissimilar from those of the *Challenger* and other like expeditions. At the same time it is believed that, in view of the type of vessel chosen, it will be possible to carry on scientific research in waters which have so far been impenetrable.

Two experienced naturalists, Miss Ormerod and Mr. Tegetmeier, have rendered agriculturists a timely service by preparing a brochure on one of the worst pests of the farm, the common sparrow. The losses caused to farmers by this feathered thief are far greater than is popularly supposed.

Mr. Joseph Lunt, B.Sc., Director of the Photographic Section of the British Astronomical Association, has been appointed Assistant at the Cape Observatory, to take charge of the telescope and spectroscopes recently presented to the Observatory by Mr. McClean for the purposes of researches in stellar spectroscopy.

The Treasury have appointed a small committee "to consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation, for the construction and preservation of standards of measurement, and for the systematic determination of physical constants and numerical *data* useful for scientific and industrial purposes; and to report whether the work of such an institution, if established, could be associated with any testing or standardizing work already performed wholly or partially at the public cost." The following will be the members of the committee:—The Lord Rayleigh, D.C.L., F.R.S. (chairman); Sir Courtenay Boyle, K.C.B.; Sir Andrew Noble, K.C.B., F.R.S.; Sir John Wolfe Barry, K.C.B., F.R.S.; W. C. Roberts-Austen, Esq., C.B., F.R.S.; Robert Chalmers, Esq., of the Treasury; A. W. Rucker, Esq., D.Sc., F.R.S.; Alexander Siemens, Esq.; Dr. T. E. Thorpe, F.R.S.

Notices of Books.

The Birds of Our Country. By H. E. Stewart, B.A. (Digby, Long, & Co.) Illustrated. Mr. Stewart's book is perhaps as good as most of the sort, viz., a book for beginners written by a beginner. That we need such books is quite another question. The text is by no means free from errors. Amongst others, we may notice that the author says that the reed warbler is the last of all our summer visitors to arrive. This is by no means the case. A number of birds arrive about the same time, while the garden warbler, the spotted flycatcher, the nightjar, and others arrive here after the reed warbler. The author makes no distinction between the plumage of the male and female bullfinch. We are told that the long-eared owl is commoner than the tawny owl in the New Forest. This may be so in one particular district, but we very much doubt if it is true of the New Forest as a whole. The curious statement is made that the roseate tern "in all probability does not now breed anywhere in the British Islands." The author is in error here. The illustrations are all "second hand," and, as in Miss Fulcher's book, reviewed in our columns last month, several are wrongly named. This practice, whether it arises from ignorance or carelessness, cannot be too strongly condemned. The illustration on page 134, called a swallow, is a martin; that on page 289, of a golden plover, is, no doubt, a dotterel; while that on page 323 is certainly not a lesser tern, since the tail is longer than the wings. Altogether we cannot recommend this book.

British Rainfall, 1895. Compiled by G. J. Symons, F.R.S., and H. Sowerby Walter. (Edward Stanford.) Illustrated. 10s. The services rendered by Mr. Symons to the United Kingdom by establishing and carrying on during nearly forty years systematic observations (now at over three thousand stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself, were recently recognized by the award of the Albert Medal of the Society of Arts to him. One of the annual volumes is before us, and in addition to being replete with facts and figures on the rainfall and meteorology of 1895, it contains an article on meteorological stations at Seathwaite—the wettest place in the British Isles. It will interest our readers to know that Mr. Symons comes to the following conclusions with reference to the observations made:—(1) The rainfall in the garden at Seathwaite is on the average one hundred and thirty-five inches a year. (2) In the wettest year it has exceeded one hundred and eighty-two inches, and may possibly reach one hundred and ninety inches. (3) In the driest year it has fallen to eighty-eight inches, and will probably never be less.

The Aurora Borealis. By Alfred Angot. Illustrated. (Kegan Paul, Trench, Trübner, & Co., Limited.) 5s. This is the eighty-first volume in the well-known International Scientific Series, and in our opinion it is a worthy addition to the series. No general work exists in which auroral phenomena are more accurately described, or which can be better understood by the general reader, than this translation of M. Angot's volume on the subject. Incidentally we may remark, however, that the fact that the book is a translation from the French does not appear to be stated either on the title-page or elsewhere in the book. The forms of the aurora, the physical characters, frequency and periodicity, the relations of the aurora to meteorological phenomena, terrestrial magnetism and earth currents, and theories to account for auroral

phenomena are all passed in review. Finally, the volume closes with a useful catalogue of the auroras observed in Europe below latitude 55° N. from 1700 to 1890. Eighteen plates illustrating typical auroral forms are distributed through the book, and though some of them are too hard in tone to be pleasing, they possess the advantage of being copies of original drawings.

Results of Rain, River, and Evaporation Observations made in New South Wales during 1895, with Maps and Diagrams. By H. C. Russell, C.M.G., F.R.S. (Department of Public Instruction, New South Wales.) The numerous publications of Mr. H. C. Russell, the Government Astronomer of New South Wales, testify to his industry both as meteorologist and astronomer. The volume before us contains the results of observations made at one thousand three hundred and fifty meteorological stations in the Colony in 1895, together with particulars of observations of river levels, evaporation, wind, tides, etc., a general discussion of the results, and an interesting paper on "The Periodicity of Good and Bad Seasons." In this paper Mr. Russell brings together a mass of evidence gathered from records of weather in all parts of the world and at all historic times, tending to show that droughts and also wet seasons recur in a cycle of nineteen years. By classifying droughts according to the number of years over which they extend, instead of according to their intensity, it was found that five sets of droughts could be distinguished, each of which showed periodicity. An ingenious diagram with which Mr. Russell illustrates his paper bears a resemblance to the keyboard of a piano, and just as each note on the board occurs in octaves, so the oblong slabs representing droughts of each type follow one another at regular intervals in time. The argument in favour of this nineteen years' cycle is very plausible, but hardly convincing enough to establish the conclusions. Nevertheless, Mr. Russell deserves the thanks of meteorologists for his painstaking effort to unravel the tangled skein of weather records.

Short Studies in Physical Science. By Vaughan Cornish, M.Sc. (Sampson Low, Marston, & Co., Limited.) Illustrated. 5s. Mr. Vaughan Cornish is favourably known to our readers by contributions which have appeared in these columns at various times. Several of the popular science essays in this volume were first published in KNOWLEDGE, one or two are reprints from other journals, and the rest are new. The sixteen essays are all instructive, and they present the matured views of men of science on prominent subjects in mineralogy, chemistry, and physics. Whoever reads the volume with understanding will acquire a store of information, and will perceive the trend of thought and work in modern physical science.

Hygiene for Beginners. By Ernest S. Reynolds, M.D. (Lond.), etc. Illustrated. (Macmillan.) 2s. 6d. The contents of this little book should be known to every man and woman in the kingdom, for both the individual and the community would gain by the extension of the knowledge which the book contains. A rough outline of the human body, and the functions of the various parts, forms the first part of the volume, and makes an admirable introduction to the second part, which is an interesting and concise presentation of the extensive and varied array of facts belonging to hygiene—the science of preventing disease.

Life Histories of North American Birds, from the Parrots to the Grackles. By Charles Bendire, Captain and Brevet Major, U.S.A. (Washington: Smithsonian Institution.) With seven Lithographic Plates. For this sumptuous volume we are indebted, as we have so often been indebted before for fine works, to the Smithsonian Institution. It forms the second volume of the "Life Histories of North American Birds," by Major Bendire, and contains a very complete and excellent account of the Psittaceous, Picarian, Picine, Macrochirine, and Passerine birds. The classification of the American Ornithologists' Union is followed, and the volume is based on the collections in the United States National Museum. The coloured plates contain excellent figures of the eggs of a number of the birds described in the text. We hear with great regret of the death of Major Bendire, and we hope that an able successor will be found to carry on the work he has so satisfactorily begun.

SHORT NOTICES.

Is the Earth a Planet? By C. Robertson, M.D. (Elliot Stock.) Illustrated. 2s. Students of mathematical astronomy will find in this little book some unique applications of Euclid's elements. Demonstration by means of triangles is so persuasive, so rational, and, in Mr. Robertson's hands, so convincing, that one might readily be led to believe that the lesser really exceeds the greater. At any rate, he has clearly shown (on paper) that "the apparent diameter of the sun—about 32′ of arc—represents a real diameter of about thirty-two geographical miles." We are given to understand that this mathematical deduction—founded on a series of prolonged observations, chiefly made in India—is in perfect agreement with all geographical facts observed in the phenomena of the seasons, and also in harmony with the fundamental definitions, as well as with the practice of nautical astronomy. "Is the Earth a Planet?" contains *such* stimulating food for the mind, and, if novelty is any recommendation, the book will certainly mark an epoch in astronomical literature.

Practical Electricity. By W. E. Ayrton, F.R.S. (Cassell.) Illustrated. 9s. Great advances in the application of electricity to industrial purposes have been made since this book of Prof. Ayrton's was first issued as an aid to electro-technical teaching, in which he has been to some extent an innovator, his method of treating the subject being analytical rather than synthetical. Most students of electricity have but the haziest notions of the exact meaning of high and low potential, the electrical analogues of hot and cold. We do not number an electrical sense among our other senses, and hence we have no intuitive perception of electrical phenomena. Prof. Ayrton, in the book before us, starts straight away with current electricity, seeking to overcome at once the great difficulties involved in the quantitative measurement of the imponderable fluid—dealing it out, so to speak, by the mile or ton, and gauging it, tracing its direction of flow, or yoking it to some machine to do useful work.

Confidences of an Amateur Gardener. By A. M. Dew-Smith. (Seeley & Co.) Illustrated. Confidences, as here exemplified, are of comparative degrees—good, bad, and indifferent. The several chapters originally appeared in the *Pall Mall Gazette* as "Wares of Autolycus." Ephemeral in their origin, devoid of design in structure, and trifling in execution, it is difficult to imagine for what purpose the papers reappear in book form, except, maybe, as a curious specimen of cultured foolishness. In each sketch of about two thousand words in length there are useful bits of information which could be told in detail in ten lines. All the rest is pepper and salt, and who cares to be feasted on these ingredients?

The Story of the Earth's Atmosphere. By Douglas Archibald, M.A. (Newnes.) Illustrated. 1s. Mr. Archibald commences his story with an account of the nebular hypothesis, and the reader quickly finds himself enveloped, so to speak, in the sweltering atmospheres of Jupiter, Saturn, the incandescent gases and vapours of the sun; and, in a while, he comes back to earth to study, in cool groves, the envelope of air, of the existence of which, perchance, he was previously unconscious, since so many incidental illustrations are used to convince one of its presence. In our opinion, the author has lost a grand opportunity. His book in parts resembles a treatise on astronomy; in other respects it trenches heavily on meteorology; and then suddenly attains to the dignity of a work on aëronautics. Since the book forms one of a series, and there is ample scope in the title assigned, one would naturally expect overlapping of subjects to be avoided as far as practicable.

Our Place among Infinities. By Richard A. Proctor. New Edition. (Longmans.) 3s. 6d. Admirers of the late Mr. Proctor will remember this little book, which consists of a series of essays contrasting our little abode in space and time with the infinities around us. The work, as a whole, deals less with the direct teachings of astronomy than with ideas suggested by astronomical and physical facts—a book in which the skeletons of facts are clothed by the aid

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of a vivid and rational imagination so as to produce images which tend to persist. Being of a fragmentary character, and lacking continuity, its chief value seems to attach to the fact that on a few special aspects of astronomy—such as the star depths, star gauging, lost comets, seeming waste in nature, etc.—the author in these essays was able to amplify his views without restraint.

A Text-Book on Shades and Shadows and Perspective. By John E. Hill. (Chapman & Hall.) Illustrated. 8s. 6d. net. The art of projection has many and varied applications. To give any object the appearance of reality, certain conventions are employed. Even fleeting shadows are useful in completing pictures, and the student of descriptive geometry usually begins the clothing of his line projections of, for example, a square pyramid on a square pedestal by filling in the complete visible shadow—the incident rays being supposed to impinge on the object in a given direction. How to do this sort of thing is well described by Mr. Hill, but it is very aggravating to find all the figures at the end of the book when they might have been inserted in the text, so as to give infinitely more satisfaction to those seeking aid therefrom. The price of the book is much too heavy.

Our Weights and Measures. By H. J. Chaney. (Eyre & Spottiswoode.) Illustrated. 7s. 6d. In this attractive volume an attempt has been made to indicate what is now the practice in the use of our various weights and measures, either in trade or for the purposes of manufacture, without, however, offering any opinion on questions affecting the construction and administration of the law which governs the practice. Origin of the imperial system, inspection of trade weights and measures, measurement of land, electrical standards, metric system, pharmaceutical weights and measures, etc., etc., are included, and indeed almost everything of prime importance in this department of knowledge. There are many first-rate collotype plates, sheets of lithographs, and numerous woodcuts, depicting every phase of the subject.

The Elements of Physics. Vol. III.—Light and Sound. By Edw. L. Nichols and W. S. Franklin. (Macmillan.) Illustrated. We have already noticed previous parts of this work, and the volume now in hand quite sustains the reputation of its predecessors. A multitude of simple figures—mere blackboard sketches—in outline, and very skilfully executed for conveying ideas, form, in our opinion, the most pleasing and useful feature of this volume. The complete absence of pictorial presentments of the regular lecture and laboratory appliances is not of much consequence to students of regular college courses of instruction, but it is, we think, a circumscribing fence which will, to some extent, limit the field of its usefulness.

We have received some handsome specimens of pictures of all sorts reproduced from original drawings and photographs by means of the "Autocopyist," a piece of manifolding apparatus. As one looks at the wonderfully collotype-like presentments of objects—animals, landscapes, architectural forms, and the like—it is almost past belief that such artistic effects can be squeezed out of an ordinary copying press. To faithfully reproduce handwriting and pen-and-ink sketches in outline is an everyday piece of routine which calls for no special remark here; but to turn out, in the way indicated, reproductions of photographs which can barely be distinguished from the originals, is an achievement which requires only to be seen to be appreciated—all the distinguishing features of silver, bromide, and platinotype prints being very closely imitated.

BOOKS RECEIVED.

Lessons in Elementary Biology. By T. Jeffery Parker, D.Sc., F.R.S. (Macmillan.) Illustrated. 10s. 6d.

Register of Examination Results for Teachers. By James M'Cubbin, B.A. (Bell.) 1s. net.

Homburg and its Waters. By N. E. Yorke-Davies. (Sampson Low, Marston, & Co.) 1s. 6d.

Theory of Electricity and Magnetism. By Charles Emerson Curry, Ph.D. (Macmillan.) Illustrated. 8s. 6d. net.

Euclid: Books I.-IV. By Rupert Deakin, M.A. (Clive.) Illustrated. 2s. 6d.

The Tutorial Trigonometry. By W. Briggs, M.A., and G. H. Bryan, D.Sc., F.R.S. (Clive.) 3s. 6d.

Tables for Computation of Star Constants. As Arranged by E. J. Stone and Revised by H. H. Turner. (Frowde.) 2s.

The Process Year Book for 1897. (Penrose & Co.) Illustrated. 2s. 6d.

Practical Astrology. By Alan Leo. (Office of *Modern Astrology*, Bouverie Street, E.C.) Illustrated. 3s. 6d.

The Epic of Sounds: an Interpretation of Wagner's "Niebelungen Ring." By Freda Winworth. (Lippincott.) Illustrated. 3s. 6d.

The A B C of the "X" Rays. By Wm. H. Meadowcroft. (Simpkin.) Illustrated. 4s.

Volcanoes of North America. By Israel C. Russell. (Macmillan.) Illustrated. 16s. net.

Comparative Anatomy of Vertebrates. By Dr. Wiedersheim. Translated by W. N. Parker, Ph.D. (Macmillan.) Illustrated. 12s. 6d. net.

Forty-fourth Report of the Department of Science and Art. (Eyre & Spottiswoode.) 2s. 7d.

KINETOGRAPHY: THE PRODUCTION OF "LIVING PICTURES."

By H. SNOWDEN WARD, F.R.P.S., Editor of *The Photogram*.

LAST winter saw the "living pictures" adopted as the craze of the season for music-halls, bazaars, and variety entertainments generally; the coming winter bids fair to establish the same class of work as a recognized aid to scientific investigation, and especially to teaching. Not that the music-halls discovered the process, for long before it was known by the public, kinetography, under various titles, did admirable scientific work in the hands of Marey, Anschütz, Muybridge, and others.

In the popular mind the invention of "living pictures" is generally attributed to Edison; in the scientific mind to Marey or Muybridge; and few are aware that in 1864 the idea was protected by two French patents in the name of Louis Ducos du Hauron. The principles involved were stated in a paper communicated five years earlier, by the same worker, to the Society of Sciences and Arts at Agen; and it seems curious that not only this process, but also the three-colour method of "photography in natural colours," should have been worked out by one man—a man who has received but little credit for his labours.

Just as the three-colour work was checked and hindered for want of the colour-sensitive plates which we now possess, the "living pictures" were long confined to the realm of scientific curiosities for want of the sensitive dry-plate emulsions and the transparent flexible supports which are now in the hands of everyone.

The seeds sown by Du Hauron were biding their time, and many men were ready, as each step was made in photographic invention, to apply the new-found powers to the perfecting of his ideas. Fortunately for kinetography, the earliest workers to develop its possibilities were not mere mountebanks or showmen, but patient scientific investigators, led by a love of truth. For many years three men—Marey, Muybridge, and Anschütz—were steadily investigating the laws and phenomena of animal movement, their results appearing in the form of scientific monograms, books, and lectures, first of a purely technical, and latterly of a more popular nature.

Marey worked, first, in a private capacity, and in a small way, but latterly, for the bulk of his valuable work, has had the support of the city of Paris, with the use and control of its physiological station. His observations on a host of questions of motion, interesting to hydraulic and civil engineers, naval and military experts, artists, naturalists, and physiologists, are most accessible to British readers in his book, "Movement," published in 1895 by Wm. Heinemann, 21, Bedford Street, London.

Eadweard Muybridge, of Philadelphia, worked in his own way, simultaneously with Marey, and the chief result of his efforts was an enormous series of studies, many of them in large sizes, which he offered for subscription to the great libraries and colleges of the world. His course of lectures, too, delivered in the United States and in Britain, did much to direct the attention of the public to the fascination and the practical utility of this method of studying motion.

Ottomar Anschütz, of Lissa, Posen, though perhaps not quite so early as Marey and Muybridge, was still one of

the earlier workers, studying first in the excellent little "Zoo" at Lissa, and later, when he had obtained the recognition of the Government, in the Gardens in Berlin. For the display of "living pictures" he designed an "electric tachyscope," in which the successive phases of a motion were mounted near the edge of a circular disc of glass. This revolved behind a small spy-hole with a lens inserted, and as each little picture passed behind the lens it was momentarily illuminated by an electric flash. Fitted up as "penny-in-the-slot" machines, these tachyscopes were shown in shops along the Strand and Oxford Street, and also at some of our popular seaside resorts, four or five years ago. Anschütz arranged, also, at the World's Fair in Chicago, 1893, a theatre for what we now know as a display of kinetography, or "living pictures."

Long after these workers had solved the problem of kinetography—after our own English worker, Friese Greene, had taken out a patent and shown his apparatus at St. James's Hall (in July, 1889)—the great American exploiter, Thomas Alva Edison, took up the subject. As he himself says, his business is not with pure science or abstract investigation, but with the application of scientific principles, new or old, to the requirements of the public. In kinetography, as in many other things, he pieced together and popularized the work of other men, and reaped the benefit. His notion was to combine the "living pictures" with the loud-speaking phonograph record, so that the actions and the words of a popular speaker or a troupe of actors might be simultaneously reproduced an indefinite number of times.

At the same time, the brothers A. and M. Lumière, in Paris, and Birt Acres, in London, were working on the same problem, and almost simultaneously three machines, differing in detail, but accomplishing the same object, were introduced to the public. Edison was in the most advanced state of preparation, and his production of results, with the newspaper "booming" which any of his work is sure to receive, rather forced the hands of the others. Their advent, as we all know, led to the designing of a host of machines—good, bad, and indifferent—for the projection of "living pictures," and the popularity of the subject led to the production of many badly executed pictures and the employment of many incompetent operators—with the result that the reputation of the process has suffered.

Kinetography is based upon the principle of the well-known zoetrope, or wheel of life, in which a series of pictures representing the successive phases of an action are ranged round the inside of a drum and viewed through a series of slits from the opposite outer side of the drum. As each slit passes the eye it gives a clear glimpse of the figure momentarily opposite to it, and the blackened part of the drum between the slits shuts out the view of the picture while it is moving along, and until the succeeding one has taken its place. In the kinetographic lantern the same effect of movement is obtained by photographing upon a strip of sensitive celluloid film a series of rapidly succeeding phases of motion, and projecting the series of pictures in rapid succession upon a lantern screen. The strip of film on which the pictures are made is an inch and a quarter wide by fifty or seventy-five feet long, or even longer. Each side of the film bears a row of holes to fit the sprockets of the wheels by which it is driven, and between these rows of holes is a long succession of tiny pictures seven-eighths by five-eighths of an inch. The machines for passing these strips in front of the light from the lantern are very varied, and amongst them include almost every possible mechanical motion whereby a strip of flexible material can be rapidly and alternately moved forward and stopped.

During the moment when the strip is moving forward to bring the succeeding picture into play, the light is cut off from the screen by means of a shutter. Hence the picture on the screen is really a quick succession of images, each one different from the preceding, and between each image and the next is a period of darkness. This rapid succession of light and shade is the cause of the "flicker" which is one of the drawbacks of kinetographic exhibitions, and which is often mistaken for unsteadiness of the picture. In the early days, owing to imperfect machines, and especially to irregularities in the perforations, the objects were apt to dance about the screen in a most erratic fashion. In a modern exhibition, though there is still the flicker, there is no excuse for vibration.

It may be said that the problem of last year was to get rid of vibration; of this year it is to overcome "flicker." Attempts have been made in the past, but with only partial success. Translucent and perforated shutters have been used, so that the light is not entirely cut off from the screen while the pictures are being changed. But the gain in one direction is more than lost in another, for any mixture of indefinite light with the screen image has the effect of so much fog. The best success has been attained by changing movements which leave each picture steadily on the screen for the longest possible, and make the change of pictures in the shortest possible, time. Amongst the patents taken out for machines which will be on the market this winter, are three (at least) which promise to completely overcome "flicker." It is obvious to anyone who studies the matter for a time that the simple solution of the problem is to use two films, exposing them alternately when making the original kinetograms, and projecting the images in a double lantern, in such a way that one picture is always on the screen while the alternate film is changing. This method works perfectly, but, unfortunately, it involves immensely more cost and more skill in operation, so that it is not considered within the realm of practical kinetography. To show the successive pictures of one single film in such a way that there is always one projected upon the screen, and no changing of a picture while it is being projected, seems impossible. Yet it can be done, in more ways than one; and it is only because the ingenious inventors of these methods have communicated them to me in confidence, and because their applications for patents are still pending, that I do not explain the means. Suffice it to say that there is every reason to believe that the coming winter will see "flicker" overcome; and that with the use of but one film and one lantern.

Of the future of kinetography I need say little. It seems certain that as an adjunct to the optical lantern the kinetographic lantern will be indispensable to every popular lecturer; and I hear that a strong syndicate of able business men propose to open a theatre in London where every British event of importance will be shown in "living picture" on the evening of the day of its occurrence, and where the great events of the world, such as the Græco-Turkish war, will be reproduced through the labours of "special" kinetographers.

Of the scientific applications I have already briefly spoken; there are just two others to which reference must be made. Some time ago Dr. Macintyre, of Glasgow, secured the first kinetographic radiogram, which enables him to show to a class of students the movement of the bones in the leg of a living frog. In New York, Dr. Robert L. Watkins has overcome the great difficulties of kinetographing microscopic objects, and has made pictures of rotifers in movement at the enormous speed of two thousand five hundred pictures a minute. As it is possible to project these at much lower speeds, one becomes able to study the

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detail movements, just as M. Marey has already done with the flight of insects. In the same way, of course, slow movements may be kinetographed at leisurely speed, and projected much more quickly. By this means it is possible to observe in a few minutes, in the most wonderful manner, the whole growth and development of a plant, from its first tiny shoot above the earth to the completion of flowering, fruiting, and the fall of the leaf; or, in the same way, a record could be made of a man's development and decline—"from the cradle to the grave"—the whole of which could be represented in a few minutes. But I must not speculate on the possibilities of the process. My wish has been to make it clear that kinetographing is far from being merely the passing fancy of the music-hall public; that it is a new and powerful means of scientific record and research.

PHOTOGRAPH OF THE NEBULA HERSCHEL V 14 CYGNI.

By ISAAC ROBERTS, D.Sc., F.R.S.

THE photograph annexed covers the region between R.A. 20h. 49m. 4s. and R.A. 20h. 54m. 49s. Declination between 30° 14·2′ and 31° 50·6′ north. Epoch 1900.

Scale, one millimètre to twenty-four seconds of arc.

The star *preceding* the nebula and nearly opposite the centre is D.M. 4254 Zone + 31°, magnitude 6·7, R.A. 20h. 49m. 24·7s., Declination + 31° 15·0′; and the star *following* the nebula is D.M. 4292 Zone + 31°, magnitude 7, R.A. 20h. 54m. 38·7s., Declination + 31° 15·4′.

The photograph was taken with the twenty-inch reflector on November 4th, 1896, between sidereal time 21h. 18m. and 0h. 13m., with an exposure of the plate during 2h. 55m.

The nebula is No. 6992 in the New General Catalogue, and has been observed and described by Sir J. Herschel and Lord Rosse; but only photographs can present it in a form that is intelligible, for it is not possible to depict by hand, with sufficient accuracy, the complex structure of this and of similar nebulæ.

On examination of the photograph we see that the nebula extends in *south following* to *north preceding* directions, and measures eighty minutes of arc in length; its structure is wavelike, with indications of irregular disturbances throughout its mass, and at the southern part there is a half-drum-like formation of the wave structure, with extensions of the nebulosity towards the south. The wave structure has immersed in it faint nebulous stars as well as irregular condensations of nebulous matter, whilst stars of the normally finished form, between the tenth and seventeenth magnitudes, are densely strewn over the whole surface of the nebula and over many degrees of the sky around it.

A photograph measuring seventeen degrees in diameter, with the nebula as the centre, was taken simultaneously with the reproduced plate, but with the Cooke five-inch lens. This shows that there are patches of this wavelike nebulosity extending over an area of two and a half degrees in diameter in the direction *preceding*, and it includes the nebula Herschel V 15 Cygni (N.G.C. 6960). The plate also shows, very prominently, large areas of cloudiness with reaches of clear areas dividing them, which, by the effect of contrast, have led many to assume that they are areas of true nebulosity, but in reality they are due to the light of countless numbers of faint stars that on the small scale of a portrait-lens photograph appear to be closely crowded together and resemble nebulous areas. To the eyes of the experienced examiner the true nebulosity can with certainty be distinguished from the star-cloud effects here referred to.

It is not desirable at this early period—the commencement of photo-astronomy—to speak with the confidence of demonstration concerning the origin of these wonderful objects—the nebulæ and the appearances as of whirlpool eddies amongst the stars all over the Milky Way; but our aim should be to dispel the mysterious by investigations, fitting together links in the chain of evidence, notwithstanding that we may insert some which will have to be replaced later on by others.

Attention has already been drawn, by aid of photographic illustrations in previous numbers of KNOWLEDGE, to the similarity of the curves of the stars involved in spiral nebulæ to the curves and aggregations of stars shown in the Milky Way, and that there is apparently a connection between them of cause and effect. But the nebula shown on the annexed photograph is of a different character, and the absence of gravitational effects, excepting the indication at the southern end, is conspicuous. The general appearance of the nebula is that of precipitation of invisible matter—either gaseous or of dust particles—which exists in space as clouds of vast extent.

That the methods of stellar evolution are various we have ample evidence in the different forms of nebulæ which have been photographed. There are planetary, annular, elliptic, spiral, globular, and unsymmetrical nebulæ; and they are presented to us at various angles in projection between edgewise and full face. Like the rings of Saturn, their superficies are enormously greater than their thickness; and it is quite conceivable that these objects may have been formed out of the invisible clouds of material to which I have alluded.

We know of no body whatever existing in space which has no motion of translation; but whether this invisible cloudy matter is in motion or at rest, it could be run into by another body that is in motion, with the result that whirlpool motions would be set up that would eventually develop into nebulæ of various forms, such as those which have already been, by photography, shown to exist.

If, on the other hand, the clouds themselves are in motion and collide with each other, then vortical motion would be set up over large areas, giving rise by progress of development to such nebulæ as are represented by the annexed photograph. This nebula shows signs of fission, and may pass in its process of development into symmetrical nebulæ and into stars, and again from stars into—what?

ASTRONOMICAL PHOTOGRAPHY.—II.

THE CONDITIONS WHICH DETERMINE THE LIMITING TIME OF EXPOSURE.

By F. L. O. WADSWORTH,
Astrophysicist, Yerkes Observatory.

CASE OF STARS.

THUS far we have been considering only the case of nebulæ and other extended sources. In the case of stars the conditions are very different. The intensity of a star image varies directly as the fourth power of the aperture, and inversely as the square of the focal length and the square of the mean (effective) wave-length. Neglecting this last factor, which is of secondary importance in the present considerations, we may also say that the intensity varies as the square of the angular aperture multiplied by the square of the linear aperture. Putting it in this way we see that since the brightness of the field also varies as the square of the linear aperture, the only way of

NEBULA HERSCHEL V 14 CYGNI.

By ISAAC ROBERTS, D.Sc., F.R.S.

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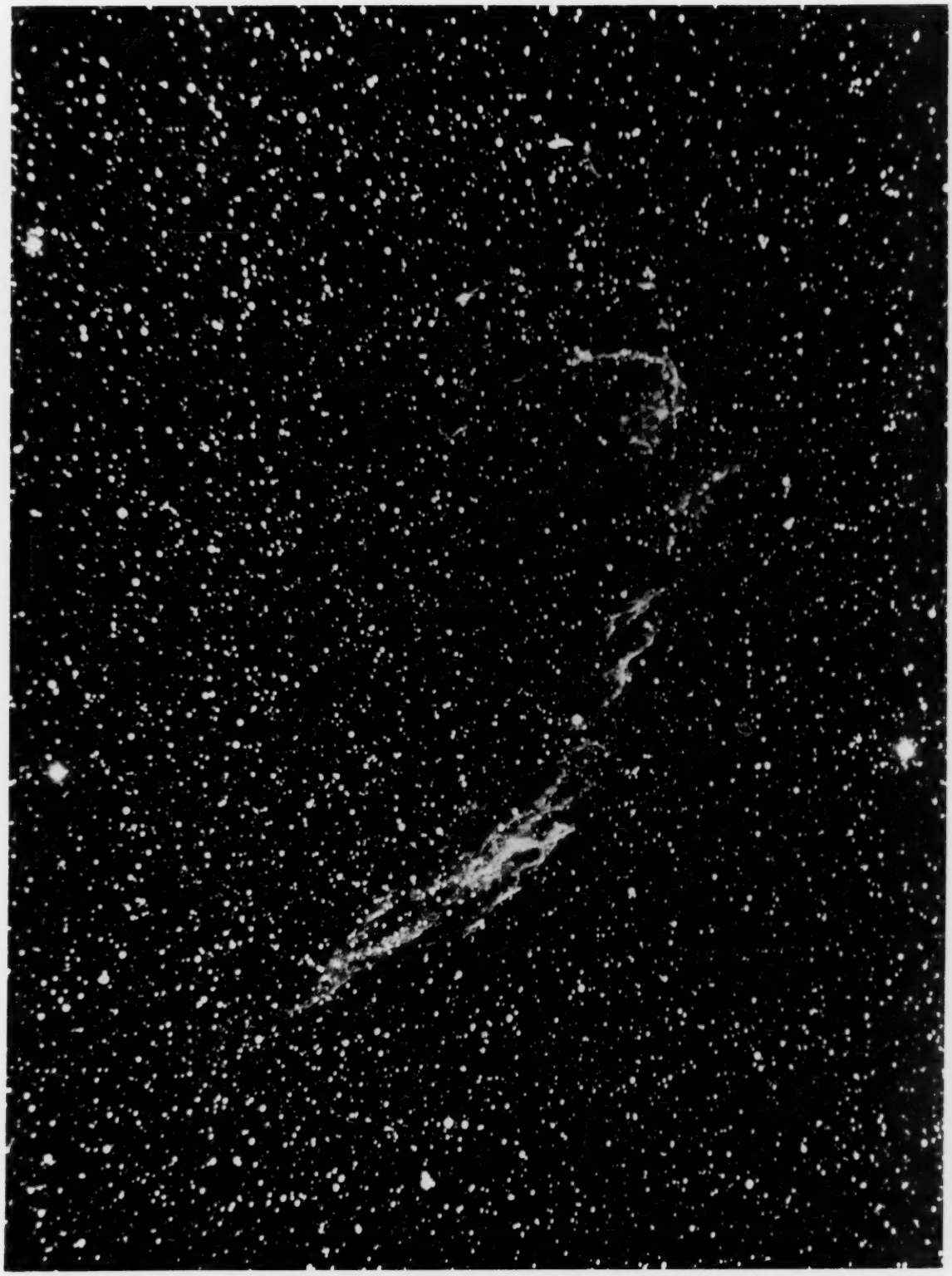

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increasing the *contrast* between sky and object in this case is to increase the angular aperture. The larger the latter the fainter the star that can be photographed. So far as the delineation of faint stars is concerned, the size of the objective—granting that the size does not affect the question of optical efficiency—is a matter of indifference; with proper exposure an objective of one inch aperture will show just as many and just as faint stars as one of ten feet aperture*—providing, of course, the image in the first case is bright enough to start photographic action, and providing also the law, that the photographic action is constant when the light action (intensity × time) is constant, holds throughout the range considered. Some recent experiments of Abney seem to show that this law is not always fulfilled in the case of very slow plates, but these are never used in astronomical photography. In practice the small lens would have an actual optical advantage over the larger one, in that it is more efficient optically—*i.e.*, a larger percentage of the incident light is transmitted, less being lost (at least in case of lenses) by absorption, dispersion, etc. This advantage will be treated more in detail a little later. The small instrument has also, of course, a great advantage in being very much less expensive both as to optical and mechanical parts, in being more rigid, allowing better following, and in being more conveniently handled. Its disadvantages are the smaller scale of the photograph, and the increase in exposure time necessary to show stars of a given magnitude. With a given angular aperture such as we have assumed in this case as a basis of comparison—because upon this alone depends the *contrast* between sky and star—the scale of the photograph varies directly as the linear aperture, and the time of exposure (theoretically) inversely as the square of the linear aperture. As a matter of fact, the exposure time necessary with the larger lens has been found to be longer than indicated by the above comparison; a fact which was long ago predicted by Sir Howard Grubb,† and which is undoubtedly due to the greater optical efficiency (less loss by absorption, etc.), already referred to, of the smaller size objectives.

Since the available *contrast* between the field and the star image depends simply and solely on the angular aperture, and since for practical reasons an angular aperture larger than that of Dr. Roberts' instrument (one-fifth) can hardly be employed on account of the practical optical difficulties of construction, it would follow that the latter's conclusion as to the limiting magnitude of stars photographically visible would hold (although, as we have already seen, it does not hold at all for nebulæ or extended objects), provided the time of exposure which he sets is really the limiting time of exposure for his aperture—twenty inches. That it is, however, is doubtful in view of the practical experiences of many other observers. I have collected some evidence on this important point, which is presented in the following table. For comparison I have assumed that all secondary conditions affecting time of exposure (such as condition of sky, sensitiveness of plate, method of development, and optical efficiency of instrument) are the same in the different cases. The first column contains the name of the observer; the second, the reference to the paper containing details respecting exposure, etc.; the third, the linear aperture of the instrument; the fourth, the time of exposure; and the last, the time of exposure reduced to an aperture of twenty inches (that of Roberts' instrument), by multiplying the given time by the square of the ratio of apertures.

Observer.	Reference.	Linear Aperture.	Longest Exposure.		Corresponding Exposure for 20-inch Aperture.	
			HRS.	MINS.	HRS.	MINS.
Gill ...	Roberts' Paper ...	13-in. (?)	24	53	10	31
Stratonoff	A.N., Vol. 141, p. 104	13-in.	25	0	10	34
Stratonoff	A.N., Vol. 142, p. 57	13-in.	20	0	8	27
Pickering	A.N., Vol. 143, p. 230	24-in.	6	0	8	38

No one of the three observers whose results are given in the preceding table say anything about having reached the limit of exposure time on account of the darkening of the plates, and all of them have given a considerably longer (equivalent) exposure than Dr. Roberts. The reason for the difference may lie either in the greater sensitiveness of the plates used by Dr. Roberts; to some difference in development; to greater brightness of sky in England than at the other stations; or, lastly, to a greater optical efficiency of the refractor (all the instruments whose performance is cited above were of this class) as compared with the reflector. As regards the first two reasons, it is equally fair to consider that on the one hand Dr. Gill, Dr. Stratonoff, and Prof. Pickering's plates were just as sensitive as Dr. Roberts', and that, on the other hand, the latter's skill in development is fully as great as that of any of the others. As regards the third reason, Dr. Roberts holds that he has eliminated this factor in the limiting time of exposure from consideration by experiments extending over many nights of varying quality. In passing it may be stated that it does not appear to the writer just how this can be done. It is certainly true that the darkening of the film will depend directly on the brightness of the sky, and the darker the latter the longer the possible time of exposure. The limit set by Dr. Roberts as the result of his work in England might therefore easily be exceeded with the same instrument, same plates, and same development, at another station more favourably situated. Finally, as regards the last possible cause of difference, I feel that so much has already been said as to the relative advantages of reflectors and refractors that an apology is almost necessary for bringing up the question again. Nevertheless, I do not believe the question is by any means settled. While practical experiment is certainly a valuable guide to a conclusion, one is apt to fall into generalizations not at all warranted by experiments made under a limited variation of conditions. It seems to me, for example, that Dr. Roberts' conclusions as to the relative advantages of the two classes of instruments have been too hastily drawn. In his experiments* with his reflector of twenty inches linear aperture and ninety-eight inches focus (angular aperture about one-fifth), and with two portrait lenses, one of three and a half inches aperture, 9·56″ focus (angular aperture $\frac{1}{9\cdot74}$), and the other of five inches aperture and 19·22″ focus (angular aperture $\frac{1}{3\cdot84}$), he

* The reason why a large aperture is necessary to render very faint stars *physiologically* visible is that in the case of the eye a certain minimum *intensity* of light is necessary to produce a retinal impression. In the case of the photographic plate it is *quantity* of light, not *intensity*, which is principally in question—although the question may be raised whether there is not a limit beyond which no action at all will take place, no matter how long the light acts. On this point Captain Abney is quoted by Russell as saying: "I have made experiments, and can say distinctly that there is, so far as I know, no light so feeble that an accumulation of it will not give an image upon the photographic plate." ("Popular Astronomy," Vol. II., p. 462.)

† *Monthly Notices*, April, 1887, p. 309.

* "On the Relative Efficiency of a Reflector and of Portrait Lenses for the Delineation of Celestial Objects." *M N.*, April, 1896, p. 372.

gives the same simultaneous exposure in all three cases, develops the resultant negatives in the same manner, and then proceeds to compare the results as to general appearance, and also by counting the number of stars shown on the three plates. Either of these methods of comparison must under the conditions be unfair to the larger or the smaller instruments. For, the relative exposure times being very different in the three cases, the method of development best suited for one would be entirely inappropriate for the others, particularly for bringing out nebular details. For nebular details the *relative* exposures would be about in the ratio of one, one hundred and four, and twenty-six respectively.* It is no wonder that the plates taken with the smaller lens were "badly fogged" by the development given to the others. And under such circumstances the plates taken with the portrait lenses would show less detail in the nebular structure, even if the very much smaller scale of the photographs was not taken into consideration at all. The comparison of the *number* of stars shown on the different plates is equally misleading, for the obvious reasons pointed out by Prof. Barnard† (difference in scale of photographs, and difference in the comparative richness of different portions of the sky in stars of different magnitude).

The intensity of the star images at the focus of the three instruments would vary in the ratio $\frac{(20)^4}{(98)^2} : \frac{(3{\cdot}5)^4}{(9{\cdot}56)^2} : \frac{(5)^4}{(19{\cdot}22)^2}$ or about in the ratio of 10 : 1 : 1·1.

Considering this, and considering also that the five-inch lens was considered to show from two and a half to three times as *many* stars as the three and a half inch for a photographic effect less ten per cent. greater, it is only surprising that the *number* of stars shown by the reflector was not very much greater than actually was the case. Probably part of the star images on the plate taken with the three and a half inch lens were blotted out in the development.

There is another point of great importance in this connection that must not be lost sight of, and that is the practical effect of using very short focus (large angular aperture) combinations in increasing the general illumination of the field. The shorter the focus the greater the curvature of the lenses, and consequently the greater the quantity of light scattered by surface reflection and diffusion. For this reason the use of a larger ratio than one to five in refractors is never desirable. Dr. Roberts arrives at a similar conclusion from a different point of view, however—viz., that with larger angular apertures the stellar *images* are not as good; and in view of this it is rather surprising that he should consider the results of his comparisons as at all conclusive, leaving aside entirely the question of relative linear apertures. A comparison of some of his photographs with those of the same region of the sky obtained with the Bruce photographic telescope, which has the same angular and very nearly the same linear aperture as the twenty-inch reflector, would be much fairer and more conclusive as to the relative efficiency of the two classes of instruments.

On one point there can be no doubt (since it has been proven over and over again by experiment), *i.e.*, that up to a certain aperture (probably not less than eighteen to twenty inches) the light-grasping power of a photographic objective is greater than that of a silver on glass reflector.* In photographic work, moreover, the *way* in which the light is lost is quite as important as the quantity lost. In the refractor the larger proportion is lost by absorption (which does not produce any general illumination of the field); in the case of the reflector, diffusion and irregular reflection due to minute scratches on the film, dust on the silvered surfaces, etc., etc., play the more important part. The field of the reflector is, therefore, as a rule considerably brighter than that of the refractor. This general illumination of the field by this cause may, in certain cases, be even greater than that due to the sky, in which cases, of course, the conclusions which have been drawn respecting the influence of the latter in determining *contrast* effect with different apertures may require modification. They would not hold in their entirety, for example, in the case of such extremely large angular apertures as $\frac{1}{2{\cdot}74}$. Such lenses would be likely to soon fog the plates by light scattered from the lenses alone, no matter how small the aperture.

One advantage of the reflector which is made much of is that of a more perfect concentration of the light of differing wave-lengths into a single image. It must be pointed out first of all that the image is not properly a single image—even in the case of a perfectly corrected reflector—but a number of superposed images, each of which, in the case of a star or other point source, is a diffraction pattern whose "width" (first minima) varies directly as the wave-length, and whose intensity at the centre varies inversely as the square of the wave-length. For this reason, and because of the limited range in sensitiveness of photographic plates, only that light of wave-length near that corresponding to maximum sensitiveness contributes to any great extent to the effective photographic intensity of the image. A refractor (particularly a photographic doublet) can now be constructed so as to unite all these effective rays almost perfectly, and at the same time give a comparatively large field.

No one is a more enthusiastic advocate than I have been of the great advantage of the reflector over the refractor for astrophysical—particularly spectroscopic—investigations;† but this, I hope, does not prevent my recognizing its obvious disadvantages in other lines of work. It seems to me that not only on the ground of the much larger field obtainable, but also on account of its greater freedom from diffused light, and its greater stability during long exposures, the photographic refractor must be considered as unquestionably superior to the reflector for general work—although for particular purposes, where an unusually large linear or angular aperture and only a small field is desired (as in photographing exceedingly faint individual stars), the latter instrument may be used with advantage.

* *See* the comparison of Barnard's results with the "lantern" and the Willard lens, and also with Pickering's results with the Voightländer lens, already described.

† "On the Comparison of Reflector and Portrait Lens Photographs," *M.N.*, November, 1896, p. 10.

* *See* paper by Prof. Hale "On the Comparative Value of Refracting and Reflecting Telescopes for Astrophysical Investigation," *Astrophysical Journal*, February, 1897, p. 119. According to the table (page 127) accompanying this paper, which is based on careful experiments by Vogel on the absorption of light by different varieties of optical glass, on experiments by Langley on the reflective power of a silver surface, and on direct comparison of the refractor with the reflector by Dr. Gill, Prof. Pritchard, and others, the light-grasping power of the two forms of objective becomes equal for an aperture of about eighty-seven centimètres (about thirty-four inches). In the case of a photographic doublet more light is lost than in the case of an ordinary objective; hence I have assumed a correspondingly lower limit.

† *See* various papers in the *Phil. Mag.*, Vol. XXVIII., p. 137; Vol. XXVIII., p. 337; *Astronomy and Astrophysics*, Vol. XIII., p. 835; *Astrophysical Journal*, Vol. I., p. 52; Vol. I., p. 232; Vol. III., p. 169 (*see* particularly pp. 182 and 183); Vol. III., p. 347; etc.

In conclusion I may sum up briefly the principal points in this paper, which has run to much greater length than was at first intended.

I. The absolute intensity of the image of a celestial object, and therefore the absolute photographic light action (product of intensity × time) for a given time of exposure, will vary: (1) for extended sources, as the square of the angular aperture only; (2) for point sources, as the product of the square of the angular aperture into the square of the linear aperture.

II. The contrast between the image of any celestial object (not very near the horizon) and the general field depends upon (1) the brightness of the sky at the time; (2) the efficiency of the image-forming lens as regards perfection of figure, nature, and curvature of surfaces, etc.; (3) and upon the square of the linear aperture. If the objectives are good, the sky effect (1) and (2) is the most important.

III. For extended objects, such as nebulæ, irresolvable star clouds, etc., etc., in which we have to deal with the delineation of a surface rather than with individual points, this *contrast* can only be increased by decreasing the focal length. When the sky effect (1) and (3) is predominant, it will vary inversely as the square of the latter quantity.

IV. For point sources the *contrast* can only be increased by increasing the *angular aperture*. Under the same conditions as in II., it will vary directly as the square of this quantity.

V. It is the *degree of contrast* and not the size of *objective* (except in so far as this latter influences the contrast) that determines the limiting magnitude of the faintest object that can be photographed. This limiting magnitude for stars depends, therefore, on the angular aperture of the instrument; and for nebulæ only on the focal length.

VI. The time of exposure also depends very largely on the *contrast* between image and field, and not on the absolute intensity of the former. If the development could be suited in every case to the exposure, the time of the latter necessary to obtain any given degree of detail would vary inversely as the *contrast* within a wide range of photographic light action.

VII. As regards the influence of the character of the objective (II. (2)) upon the illumination of the field, the refractor seems to have a decided advantage. The angular aperture of the latter should not, however, be greater than one-fifth. To photograph the very faintest stars (beyond the seventeenth magnitude) a reflector of the largest possible angular aperture—one-third or one-half if possible—is the *only* instrument that can be used.

Conclusion.—In this paper I have carefully abstained from any mathematical exposition of the various relations between aperture, focal length, and intensity of image and field. Those who prefer such a method of treatment will find it, together with some further developments of the present paper, in an article "On the Conditions of Maximum Efficiency in Astrophotographic Work," in the August Number of the *Astrophysical Journal*.

THE BIRDS OF OBAN'S ISLES.

By Harry F. Witherby.

LYING in the Firth of Lorne, and within a radius of ten miles or so of Oban, there are a number of tiny islands which are well deserving of a visit from the ornithologist.

It was on May 25th that I started out from Oban Bay with two friends, in a ten-ton cutter, to explore these islands; and I intend here to give a short account of what we did, and of what we found, during the ten days in which we were cruising among the islets.

The first day we ran down to "Black Isle," so called because of its dark appearance at a distance. We stayed here all day and thoroughly explored the island.

For the benefit of those who have not visited these or similar islets, I may here describe their general character. There is usually no beach at all, seaweed-covered rocks dipping sharply into the sea surrounding the island. Above the seaweed there lies a belt of sloping rock covered with lichens of various shades of grey and yellow. Beyond this sloping fringe of rock one comes to more or less flat ground covered with grass, heather, and other undergrowth. Occasionally there are a few stunted trees on the island, and perhaps a small hill. Sometimes, too, the island itself rises on one side in a sheer cliff of eighty feet or more.

Nest of the Common Gull.

On Black Isle—as, indeed, on most of the islands round Oban—we found the fringe of lichen-covered rock tenanted by gulls (common, lesser black-backed, and herring) and oyster-catchers. The gulls' nests were very often exceedingly prettily placed. Built of withered grass, moss, and lichen, and containing two or three greenish brown spotted eggs, they were very conspicuous; yet, in colouring they were in perfect harmony with the light grey rock, covered with bright lichens and brilliant sea-pinks.

The oyster-catcher—or, more appropriately, the mussel-picker—generally lays its eggs in a little hollow scooped among the pebbles on a beach, but it also nests in considerable numbers on small islands off the mainland. Even should there be a beach on the island, it is my experience that the oyster-catcher does not use it as a nesting place, but invariably lays its eggs either in a small hollow in the bare rock, or in a scoop in the short thick turf. When using such places as a nesting site the oyster-catcher places at the bottom of the scoop a few pebbles or broken shells, or, as I have often seen, some dry rabbit dung, which it no doubt mistakes for pebbles.

This habit of placing stones at the bottom of the nest seems to indicate that in nesting on rock or grass the oyster-catcher is merely adapting itself to circumstances, and that the pebbly beach was its original breeding place.

In one of the oyster-catcher's nests which we found, the eggs were just hatching, and as I took one up in my hand and put it to my ear, I could distinctly hear the young one inside the shell shrilly uttering exactly the same note which the old bird was loudly calling overhead. In his book on "The Evolution of Bird Song," Mr. Witchell mentions a similar instance of a lapwing in the shell

uttering the old bird's cry. Mr. Witchell seems to think that this case is a proof of the cry being hereditary, but it seems to me quite possible that the young bird in the shell would be able to learn a simple cry even before it was hatched, and if this be so the note would be merely a case of imitation.

We next turned our attention to the heather with which the "Black Isle" is covered. Here and there we came across the nest of a herring or a lesser black-backed gull, but they were not so numerous as on the rocks. On walking along a small promontory a wild duck (*Anas boschas*) suddenly rose out of the heather right at our feet, and, flying some twenty yards, plunged into the sea with a splash, and then sat and watched us. We knelt down and parted the heather, and there was a beautiful nest of down, interwoven with bits of fern, moss, and heather. The nest contained ten shining eggs, almost white, but with a tinge of green. So completely was the nest covered that it was impossible to see the eggs without first parting the tall heather, and it appeared mysterious how the bird could have risen so easily and quietly.

Nest of the Wild Duck.

The only other nest of interest which we found on the "Black Isle" was a common sandpiper's, containing four eggs. This nest, too, was hidden in a clump of heather, and took the form of a perfect cup and saucer of bright green moss.

Another day we paid a very early visit to two little islands called the "Seal Islands"—so called because one generally sees two or three seals lying out upon the rocks. The larger of these islands is only a few acres in extent, yet it affords very varied scenery, and is in fact a perfect miniature of the mainland. On one side it has a perpendicular granite cliff of about one hundred feet in height; on the other it slopes down gradually to the sea. It is abundantly clothed with short undergrowth, and through the middle there runs a tiny glen, flanked on either side with steep cliffs, and containing four or five fir trees.

In exploring this island we came across a great number of shells of merganser ducks' eggs which had evidently been stolen and sucked clean. Suspecting a hooded crow, we searched about the cliffs, and soon "put up" and shot the old bird. We found her nest half-way down the cliff, and over it, on the top, was a rock pipit, still warm but half eaten. Verily, we had caught this hoodie redhanded and she deserved her death.

We now began to search the island for merganser ducks' nests. I had my arm down a hole between two rocks and fancied I felt something soft, when suddenly my companion shouted out "What's that?" Turning round, I saw a bird scuttling off amongst the heather about twenty yards away. I ran after it to see what it was, when it got up and flew quickly down to the sea. It was evidently a shelduck, and we began to search about for its nest where we had first seen the bird, but could find nothing. I went back to my original find, and discovered that there was another opening to the hole on the other side of a big rock. We therefore came to the conclusion that this hole contained the shelduck's nest, and that she had slipped off when I put in my arm, and had very craftily left by the opposite opening out of my sight, and had then crept away. We started to unearth the nest, which we succeeded in doing after half an hour's hard work, and found to our delight a shelduck's nest with sixteen eggs. The nest was the most beautiful duck's nest I have ever seen. It was entirely composed of greyish white down, with here and there a relieving point of colour in the shape of a brilliant black or chestnut feather.

On the precipitous side of the island some half-dozen pairs of black guillemots were breeding, and we were anxious to obtain their eggs, not because of their rarity, but because—in his "Fauna of Argyllshire"—Mr. Harvie-Brown seems rather doubtful whether these birds breed inside the Isle of Mull.

We tried to scale the cliff from the bottom, but found it exceedingly difficult work, since it was nearly sheer, and the only hold was in the shape of very small points of rock. After several failures I managed to scramble up to a ledge from which the nesting holes seemed accessible, but, arrived there, I found an overhanging rock beyond which it was impossible to climb. But, worse than this, I soon woke up to the fact that I was fairly "treed." It was difficult to scramble up, but to get down without a fall was impossible. I was therefore forced to squat on my little ledge, with the sea, a perpendicular drop of seventy feet, below me, while my companions went off to the boat to fetch a rope. They were away for about twenty minutes, and as I sat perfectly still on the ledge I had an admirable view of the black guillemots. Five or six were swimming in nearer and nearer to the cliff; when quite close in, they suddenly one after another rose from the water at a sharp angle, and passed with whirring wings within a foot of my face to their nesting holes just above. I shall never forget the sight—the swift and powerful flight, and the brilliant pink legs and feet pressed close to coal-black breasts!

The rope arrived, I was let down into the small boat below, and then going round was lowered over the cliff again, and found two eggs placed on a ledge inside a tiny cavern. There were other eggs, but I could not reach them.

One day we started from our anchorage, in the lee of a small island, for Tobermory, in the Sound of Mull. On approaching a small flat island in the sound we saw two shelducks circling over it, and flying gradually lower they parted company, one darting to the ground and disappearing, while the other flew on. This manœuvre is often practised by shelducks when visiting their nest. The male escorts the female until near the nest, when he suddenly leaves her and flies on. The habit no doubt often conceals the whereabouts of the nest, for one is apt to watch the flying bird and lose sight of the other. On this occasion, however, we marked the spot where the bird had gone down, and, landing, walked up to the place, and almost immediately found a burrow, in which was the bird sitting on a full nest of eggs. This burrow ran right through a bank, and thus had two

openings. Within a yard of the shieldduck's nest, and in the same burrow, was a merganser's nest with fourteen eggs. Four of these eggs were undoubtedly shieldduck's eggs, laid there by the merganser's near neighbour. It is a fairly common habit in the duck family for one bird to lay in another's nest after she has filled her own and has still eggs to lay. Curiously enough, we found another merganser's nest, with ten eggs, in some reeds quite in the open and but a few yards from the burrow. What a lovely sight it would have been, supposing all these eggs

Some of the Isles.

hatched out at the same time, to watch the three families of some forty ducklings of two species within an area of six square yards!

We had the good fortune to see many beautiful sights on this little trip, and I should like to describe (although no words of mine can do it justice) one more—the most beautiful of all. Although we had started very early one morning from Tobermory on our way back to Oban, head winds and dead calms had kept us so long in the Sound of Mull that we did not reach its mouth until nearly midnight. The soft, dim twilight was shedding an uncertain glimmer over a sea as smooth as glass, and the tide neither ebbed nor flowed. Amidst this peace and quiet in one little spot a fierce struggle was going on. We could see in the distance a troubled patch of water, from which there continually flashed glistening streaks of silver, while hovering forms above kept plunging down and rising again. Rowing quietly and slowly nearer, we found that a shoal of little fry were beset by a host of devouring foes—great fat saithe were darting up at them from below, while a flock of terns were diving down upon them from above. The water was in a constant turmoil of glistening foam as one after the other the birds dropped down like a stone, and then, emerging from the spray, rose with a tiny silvery fish across the beak. Their evolutions in the air were indeed a fascinating sight—now gliding, now hovering, now fluttering like butterflies, they flew round and round in the wake of the shoal of fish, while their "kee-er, kee-ers" sounded cheerily across the glassy sea.

THE FACE OF THE SKY FOR SEPTEMBER.

By HERBERT SADLER, F.R.A.S.

A FEW small scattered spots still appear on the solar disc.

Conveniently observable minima of Algol occur at 11h. 6m. P.M. on the **10th**, and at 7h. 56m. P.M. on the **13th**.

Mercury is too near the Sun to be well observed this month. He is stationary on the **9th**, and in inferior conjunction with the Sun on the **23rd**. He may, however, just be caught by a careful observer at the end of September, as he rises on the **30th** at about 4h. 30m. A.M., with a northern declination of 2° 18′, and an apparent diameter of 9″. While visible he describes a short retrograde path in Virgo.

Venus is a morning star, and is still very well situated for observation. On the **1st** she rises about 1h. 32m. A.M., with a northern declination of 19° 29′, and an apparent diameter of 15″. On the **10th** she rises at 1h. 56m. A.M., with a northern declination of 17° 27′, and an apparent diameter of 14¼″, about three-quarters of the disc being illuminated. On the **20th** she rises at 2h. 20m. A.M., with a northern declination of 14° 25′, and an apparent diameter of 13½″. On the **30th** she rises at 2h. 50m. A.M., with a northern declination of 10° 40′, and an apparent diameter of 13″. She describes a direct path through a portion of Cancer into Leo, being not far from Regulus on the **25th**.

Both Mars and Jupiter are invisible, Jupiter being in conjunction with the Sun on the **13th**.

Saturn is an evening star, but must be looked for as soon as possible after sunset; and his low declination interferes with observation. On the **1st** he sets at 9h. 21m. P.M., or about two and three-quarter hours after the Sun, with a southern declination of 17° 11′, and an apparent equatorial diameter of 16¼″. On the **10th** he sets at 8h. 47m. P.M., with a southern declination of 17° 21′, and an apparent diameter of 16¼″. On the **20th** he sets at 8h. 12m. P.M., with a southern declination of 17° 33′, and an apparent equatorial diameter of 16¼″. On the **30th** he sets at 7h. 32m. P.M., or about two hours after the Sun, with a southern declination of 17° 46′. During the month he describes a short direct path in Libra.

Uranus is now too near the Sun to be conveniently observed.

Neptune is an evening star, rising on the **1st** at 10h. 38m. P.M., with a northern declination of 21° 53′, and an apparent diameter of 2½″. On the **30th** he rises at 8h. 40m. P.M., with a northern declination of 21° 52′, and an apparent diameter of 2½″. During the month he describes a short direct path in Taurus.

There are no very well marked showers of shooting stars in September.

The Moon enters her first quarter at 11h. 13m. P.M. on the **3rd**; is full (Harvest Moon) at 2h. 12m. A.M. on the **11th**; enters her last quarter at 2h. 51m. A.M. on the **19th**; and is new at 1h. 46m. P.M. on the **26th**.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed, till further notice, to the Chess Editor, KNOWLEDGE, 326, High Holborn.

Solutions of August Problems.

No. 1.

(By J. T. Blakemore.)

1. B to R3, and mates next move.

No. 2.
(By C. D. Locock.)
Key-move.—1. P to B4.

If 1. . . .	K to K5,	2. Kt to B5ch, etc.
1. . . .	K to K7,	2. B to Bsq, ch, etc.
1. . . .	Kt × P,	2. Kt × Pch, etc.
1. . . .	Kt elsewhere,	2. B to Kt4ch, etc.
1. . . .	B × P or PQ6,	2. B to Kt4ch, etc.
1. . . .	Anything else,	2. Q to Ksq, etc.

CORRECT SOLUTIONS of both problems received from Alpha and Captain Forde.

Of No. 1 only from H. H. Thomas.

Several incorrect solutions have been received.

In No. 1.—B to Q6 is met by 1. . . B to Kt2 (or Bsq), leaving the White Knight pinned.

In No. 2.—The immediate threat, 1. Q to Ksq, is answered by 1. . . P × P; and if then 2. Kt × Kt, R to Q3 (!), preventing both the mates.

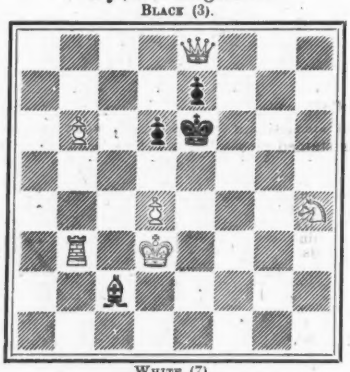
Nor will 1. K to Ktsq solve the problem, as suggested by A Norseman.

J. H. Ballantine.—In the position you send the key is weak; the Bishop at QKt6 seems uncalled for, and duals are present. Can you improve it?

W. J. Ashdown.—Could you alter your remaining problem, so as to remove some of the duals?

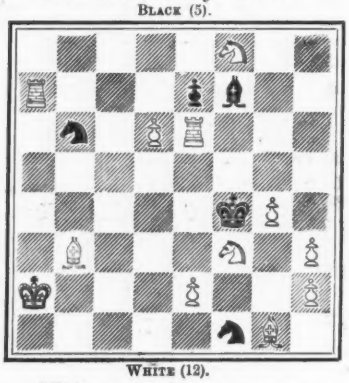
PROBLEMS.

No. 1.
By W. Clugston.
BLACK (3).



WHITE (7).
White mates in two moves.

No. 2.
From the *Birmingham News*.
BLACK (5).



WHITE (12).
White mates in two moves.

CHESS INTELLIGENCE.

An Amateur Tournament, under the auspices of the Southern Counties Chess Union, will commence at King Edward VI. Grammar School, Southampton, on Monday, August 30th, at 6.30 P.M., concluding not later than Wednesday, September 8th. There will be three level tournaments for players of different strengths; also a Ladies' Tournament, and handicaps if time permit. The entrance fees (Class I., one guinea; other classes, 10s. 6d.) should reach Mr. J. H. Blake, 2, St. Lawrence Road, Southampton, on or before Friday, August 27th. The hours of play are from 10 to 2, and 6.30 to 10.30.

An International Tournament begins at Berlin the middle of this month. The English competitors are expected to include Messrs. Bird, Blackburne, Burn, Lee, Mason, and Teichmann.

In the Summer Tournament of the City of London Chess Club Mr. Evans holds a commanding lead, Messrs. Blackburne, Physick, Jacobs, and Lawrence coming next in the order named. Mr. Blackburne lost to Mr. Evans, and drew his game with Mr. Lawrence.

A match has been arranged between M. Janowski, of Paris, and either M. Charousek or M. Maroczy, of Hungary. Messrs. Bird and Lee have also been engaged for some time in a closely contested match.

The British Chess Club has removed to new and most commodious premises, at 4, Whitehall Court, S.W., all the rooms being now on the ground floor, and handsomely decorated. Chess is by no means the only game played at the British Chess Club, and the devotees of other games are provided with ample accommodation.

KNOWLEDGE, PUBLISHED MONTHLY.

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